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April 1988

ANNUAL
REPORT
OF THE 1987
WESTERN PACIFIC
LOBSTER FISHERY

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FOR

Western Pacific Regional Fishery Management Council

ANNUAL REPORT OF THE 1948 WESTERN PACIFIC LOUPEL FISHING

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PREFACE

This is the fifth annual report on the western Pacific lobster fishery managed under the Crustacean Fishery Management Plan (formerly the Spiny Lobster Fishery Management Plan), which was prepared by the Western Pacific Regional Fishery Management Council (Council) and went into effect in March 1983. The western Pacific lobster fishery includes three management areas: permit area 1, the Northwestern Hawaiian Islands; permit area 2, the main Hawaiian Islands; and permit area 3, the islands of the territories of American Samoa and Guam. Permits are administered by the Western Pacific Program Office of the National Marine Fisheries Service and allow for lobster fishing operations in federally managed waters (3 to 200 nmi from shore). In 1987, 41 permits were issued for area 1, no permits were issued for area 3, and only 3 for area 2. Despite three permits being issued for the main Hawaiian Islands, no fishing activity was reported for the federally managed waters included in permit area 2. Therefore, all of the material presented in this report is for permit area 1, the Northwestern Hawaiian Islands.

This report provides the technical information stipulated in the Final Combined Fishery Management Plan for Crustacean Fisheries of the western Pacific region. It also 1) presents fishery information provided by the Fishery Management Research Program of the Southwest Fisheries Center Honolulu Laboratory, National Marine Fisheries Service, NOAA; 2) summarizes biological research information provided by the Insular Resources Investigation of the Honolulu Laboratory; 3) incorporates information on the activities of the Council's Crustacean Monitoring Team and Scientific and Statistical Committee (as provided by Paul D. Gates, the Council's staff biologist); and 4) reports on other pertinent research related to the western Pacific lobster fishery. Separate sections were prepared by the Western Pacific Program Office and the Southwest Enforcement Office, Honolulu.

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INTRODUCTION

This report provides details on commercial lobster fishing activity in the fishery conservation zone (FCZ) of Hawaii. Current catch, fishing effort, and revenue statistics are provided, along with revised information on the catch per unit effort (CPUE) for 1983-87. The report also provides information on the biological and economic conditions of the Northwestern Hawaiian Islands (NWHI) lobster fishery.

The NWHI lobster fishery predominately targets two species of lobster: the spiny lobster, Panulirus marginatus, and the common slipper lobster, Scyllarides squammosus. In 1987, the ridgeback slipper lobster, S. haanii, also became a target of commercial exploitation. In addition, two other species, the green spiny lobster, Parribacus penicillatus, and the Chinese slipper lobster, P. antarcticus, continued to be caught incidentally, but their quantities were very small.

The majority of the data presented here are derived from logbook information provided by active lobster fishermen. This information includes a daily record of the statistical area fished, numbers of traps set and hauled, and the number of spiny lobsters caught. Fishermen have also been requested by the National Marine Fisheries Service (NMFS) to voluntarily report the number of common slipper and ridgeback slipper lobsters caught. Cooperation has been excellent, with all vessels reporting the total numbers of common slipper lobsters caught and many also reporting the numbers of ridgeback slipper lobsters caught. In addition, at the end of each fishing trip, the vessel operator or owner is required to submit to the NMFS a revenue report that details the type and weight of, and the revenue received for, spiny lobster products landed. The same information has been requested for slipper lobster products, and cooperation has also been excellent. Amendment 5 to the Crustacean Fishery Management Plan (FMP) requires reporting of slipper lobster catch and revenue in 1988.

In 1987, 11 federally permitted vessels operating in the FCZ of the NWHI caught 440 metric tons (t) (wet weight) of spiny and slipper lobsters. Gross revenue was an estimated \$4.1 million based on ex-vessel price. Spiny lobster products continued to be the top generator of revenue in the fishery, with 240 t landed in 1987 and valued at \$2.5 million. Slipper lobster products were the second largest generator of revenue in the fishery, with 200 t valued at an estimated \$1.6 million. Total ex-vessel revenue in 1987 decreased 33% from the record 1986 revenue; the combined weight landed (wet weight) dropped by 56%. Total effort (in **trap-hauls**) in 1987 decreased by 40% from the 1986 level. Fewer vessels participated in the fishery (11 in 1987 vs. 16 in 1986), and those vessels remaining were predominately the medium-sized Class II and III vessels (for definitions of vessel Classes 0-III, see Clarke and Pooley in press). Combined catch (legal spiny and total slipper lobsters) **per trap-haul** in 1987 decreased by 31% from the 1986 level.

Economic research indicated that in 1986 the return on investments differed significantly between vessel classes in the fishery. Fleet-wide analysis shows that overall there was little economic profit from the fishery in 1986, and as is the case for other open access fisheries,

vessels making profits were counterbalanced by those losing money. The same appears to be true in 1987.

Biological assessment shows that, at certain banks, lobster stocks are under biological stress due to heavy exploitation. However, there is no evidence of recruitment overfishing. Catch per trap-haul is predicted to continue to decline in 1988, at current effort levels, with CPUE declining more at some banks than others. Preliminary analysis indicates that certain banks that came under intense exploitation in the last 3 yr may not stand up to fishing pressure as well as several banks with a longer history of exploitation. Despite a significant drop, effort levels appear to be excessive in the fishery at present.

LANDINGS

Revenue and Landings Data

Summaries of the NWHI lobster products landed in 1977-87 are presented in Tables 1 and 2. Landing weight statistics (Table 1) are presented by year, wet weight calculated on a whole animal basis, and total ex-vessel revenue estimated for spiny and slipper lobsters. Table 2 presents a breakdown of revenue by product type (live, frozen whole, or frozen tails) and actual product weight landed.

Revenue figures for 1986 in Clarke et al. (1987) have been revised slightly (Table 2) because of amendments or corrections of filed revenue reports. In addition, six of the Trip Sales and Processing Report forms were delinquent and required estimation for 1986. The landings and revenue estimates for those six reports were estimated from information received from the vessel operators at the time of off-loading. The complete estimation procedure was described in detail in Clarke et al. (1987). Those six reports are still outstanding, and as a result, the 1986 revenue and landings remain technically incomplete.

In 1986, slipper lobster revenue was reported on a voluntary basis for 39 out of 60 trips. In addition, six trips were reported at the time of off-loading. The remaining 15 revenue and landing weights were estimated by the procedure in Clarke et al. (1987).

In 1987, all Trip Sales and Processing Report forms have been received except one. Three trips have been reported on a preliminary basis and are awaiting final sales of all lobster products. Spiny and slipper lobsters were reported by all vessels (with only the one outstanding report as the exception).

Landings and Revenue

In 1987, 240 t of spiny lobster and 200 t of slipper lobster were landed from the NWHI lobster fishery, representing a significant reduction from the 1986 landings (Table 1). These weights represent whole wet weight

Table 1.--Estimated annual sales of spiny lobster and slipper lobster, 1977-87. Ex-vessel price is in U.S. dollars per pound, and ex-vessel revenue is in U.S. dollars per pound. Weight is in terms of whole animals, as is ex-vessel price. See text for source of data.

Year	Spiny lobster				Slipper lobster				Vessels (No.)	Trips (No.)
	Pounds ^a	Metric tons	Price	Revenue	Pounds ^b	Metric tons	Price	Revenue		
1977	72,000	30	2.90	209,000	—	—	—	—	5	14
1978	45,000	20	3.00	135,000	—	—	—	—	2	12
1979	100,000	50	3.20	320,000	—	—	—	—	2	6
1980	328,000	150	3.40	1,115,000	—	—	—	—	3	12
1981	780,000	350	3.50	2,730,000	—	—	—	—	10	25
1982	187,000	80	3.60	673,000	—	—	—	—	7	19
1983	203,000	90	2.91	591,000	—	—	—	—	4	19
1984	935,000	425	2.66	2,490,000	220,000	100	1.64	361,000	11	38
1985	1,438,000	654	2.94	4,227,000	930,000	423	1.78	1,660,000	16	62
1986	1,149,000	521	3.23	3,710,000	1,053,000	479	2.16	2,272,000	16	60
1987 ^c	528,000	240	4.71	2,491,000	439,000	200	3.59	1,577,000	11	38

^aIncludes frozen tail weight expanded to represent whole weight (tail weight = 35.6% of whole weight).

^bIncludes frozen tail weight expanded to represent whole weight (tail weight = 33.3% of whole weight).

^cPreliminary estimate.

Table 2.--Estimated annual sales of spiny lobster and slipper lobster by product type. Ex-vessel price is in U.S. dollars per pound, and ex-vessel revenue is in U.S. dollars.

Year	Product	Type	Spiny lobster				Slipper lobster				Vessels (No.)	Trips (No.)
			Pounds	Metric tons	Price	Revenue	Pounds	Metric tons	Price	Revenue		
1977	Live		72,000	33	2.90	208,800	—	—	—	—	5	14
1978	Live		45,000	20	3.00	135,000	—	—	—	—	2	12
1979	Live		100,000	45	3.20	320,000	—	—	—	—	2	6
1980	Not available											
1981	Not available											
1982	Not available											
1983 ^a	Live		25,000	11	4.46	111,600	—	—	—	—	4	12
	Frozen	Whole	15	0	4.00	60	—	—	—	—	1	1
	Frozen	Tails	51,400	23	7.41	380,800	—	—	—	—	2	7
1984	Live		36,500	17	4.70	171,700	—	—	—	—	7	9
	Frozen	Whole	3,500	2	3.98	13,800	100	— ^b	3.00	400	3	6
	Frozen	Tails	318,600	145	7.23	2,304,500	27,300	12	4.92	134,000	10	31
1985	Live		35,200	16	4.71	165,800	30	— ^b	3.90	100	7	21
	Frozen	Whole	2,800	1	4.08	12,800	600	— ^b	2.73	1,600	3	8
	Frozen	Tails	498,000	226	8.13	4,050,000	310,000	141	5.35	1,660,000	15	56
1986 ^c	Live		18,200	8	5.10	92,880	100	— ^b	5.25	600	6	16
	Frozen	Whole	15,500	7	3.84	59,500	3,600	2	2.45	8,700	6	9
	Frozen	Tails	397,000	180	8.96	3,558,000	350,000	159	6.47	2,263,000	16	56
1987 ^d	Live		12,400	6	6.50	80,900	5,548	3	7.29	40,400	3	9
	Frozen	Whole	800	— ^b	5.78	4,600	1,800	1	3.96	7,100	2	3
	Frozen	Tails	183,700	83	13.06	2,405,000	143,927	65	10.64	1,529,600	10	37

^aApril through December 1983.

^bLess than 1 metric ton landed.

^cDevised from 1986 annual report.

^dPreliminary figures.

extrapolated from product weights reported on Trip Sales and Processing Report forms. Compared to record 1986 landings, wet weight declined 54% for spiny lobsters and 58% for slipper lobsters. Spiny and slipper lobster landings were the lowest since the 1982-84 period (Fig. 1). Total gross revenue for the NWHI lobster fishery was \$4.1 million in 1987, less than in 1985 and 1986. The 1987 gross revenue figure represents a 33% decline in total ex-vessel revenue from revised 1986 gross revenue of \$6.0 million.

Spiny lobster ex-vessel revenue was \$2.5 million in 1987, down 33% from revised 1986 revenue of \$3.7 million (Fig. 2). This represents the second straight year that total spiny lobster revenue has declined. In 1985, spiny lobster products generated \$4.2 million in revenue, or 63% greater than in 1987. Slipper lobster revenue for 1987 was \$1.6 million, down 31% from the revised 1986 figure of \$2.3 million. The decline in 1987 slipper lobster revenue is approximately equal to the increase seen in the 1985-86 period.

Production by Product Type

Continuing a 5-yr trend, frozen lobster tails were the predominate product type of the NWHI lobster fishery (Table 2). In 1987, the sale of frozen tails accounted for 97.4% of the total estimated revenue generated from spiny lobster products, with the live and frozen whole lobsters accounting for only 2.4 and 0.2%, respectively. Frozen tails accounted for 97.0% of the revenue generated from slipper lobster products, with live and frozen whole slipper lobsters accounting for the 2.6 and 0.4%, respectively.

The only area of increase in slipper lobster revenue was an increase in live slipper lobster revenue, with approximately \$40,000 reported. Many of the vessels that documented live lobster sales reported difficulty in separating weights of live spiny and slipper lobsters and, as a result, normally reported all sales as live spiny lobsters. It is likely that live slipper revenue was more on the order of \$60,000 or half of the reported landings of combined live spiny and slipper lobsters. In 1987, about 18,000 lb (8,178 kg) of live lobsters were reportedly sold. Observations by dockside samplers indicated that approximately 50% of the live loads were slipper lobsters, with an increasingly greater incidence of ridgeback slipper lobsters, especially toward the end of 1987. There was reportedly no difference in ex-vessel price for live spiny, common slipper, or ridgeback slipper lobsters. All species were selling for \$7.00-\$7.50/lb (ex-vessel) at the end of 1987.

Frozen spiny lobster tails provided the largest source of income (\$2.5 million) in the NWHI lobster fishery in 1987 (Fig. 3). However, the 1987 revenue from spiny lobster frozen tails declined by 33%, from the 1986 level of \$3.6 million. Slipper lobster frozen tails continued to be the second largest generator of revenue in the NWHI lobster fishery at \$1.5 million. However, for the first time since 1983, when revenue data on slipper lobster landings were initially documented, weight of lobsters landed and revenue declined. In 1987, revenue from slipper lobster frozen tails was down 32.5% from 1986.

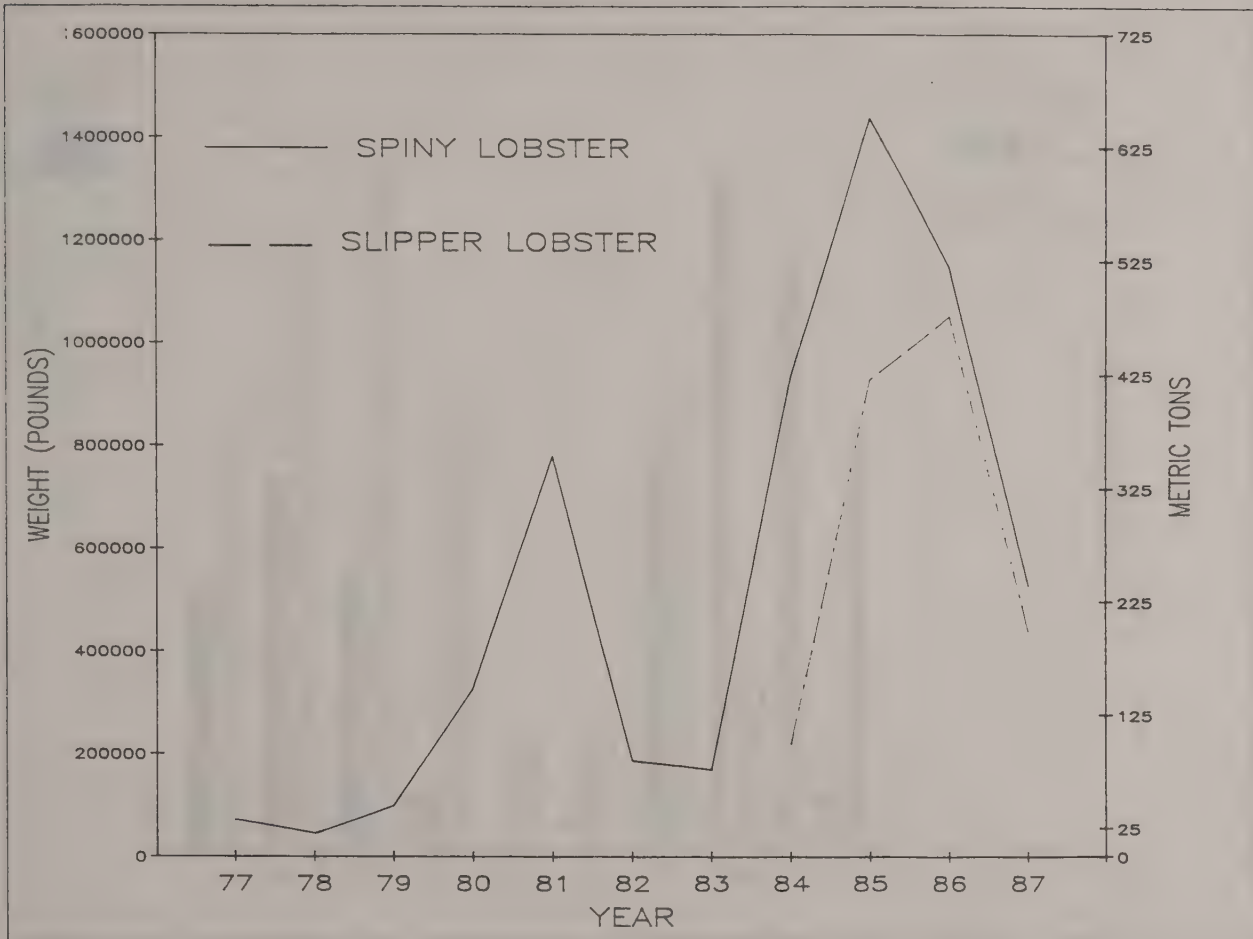


Figure 1.--Estimated annual landings of spiny lobster and slipper lobster for the lobster fishery in the Northwestern Hawaiian Islands, 1977-87 (wet weight).

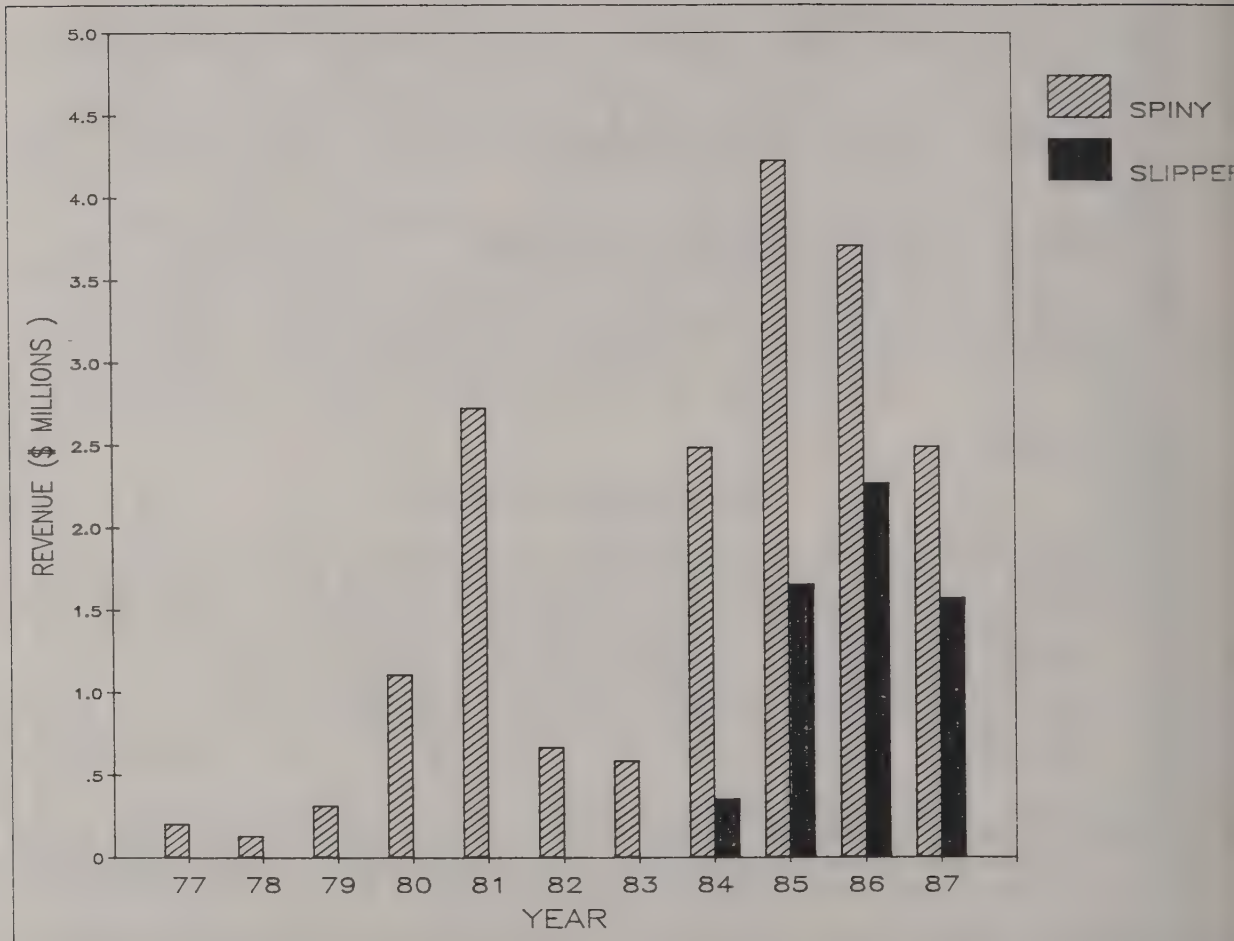


Figure 2.--Revenue for spiny lobster and slipper lobster for the lobster fishery in the Northwestern Hawaiian Islands, 1977-87.

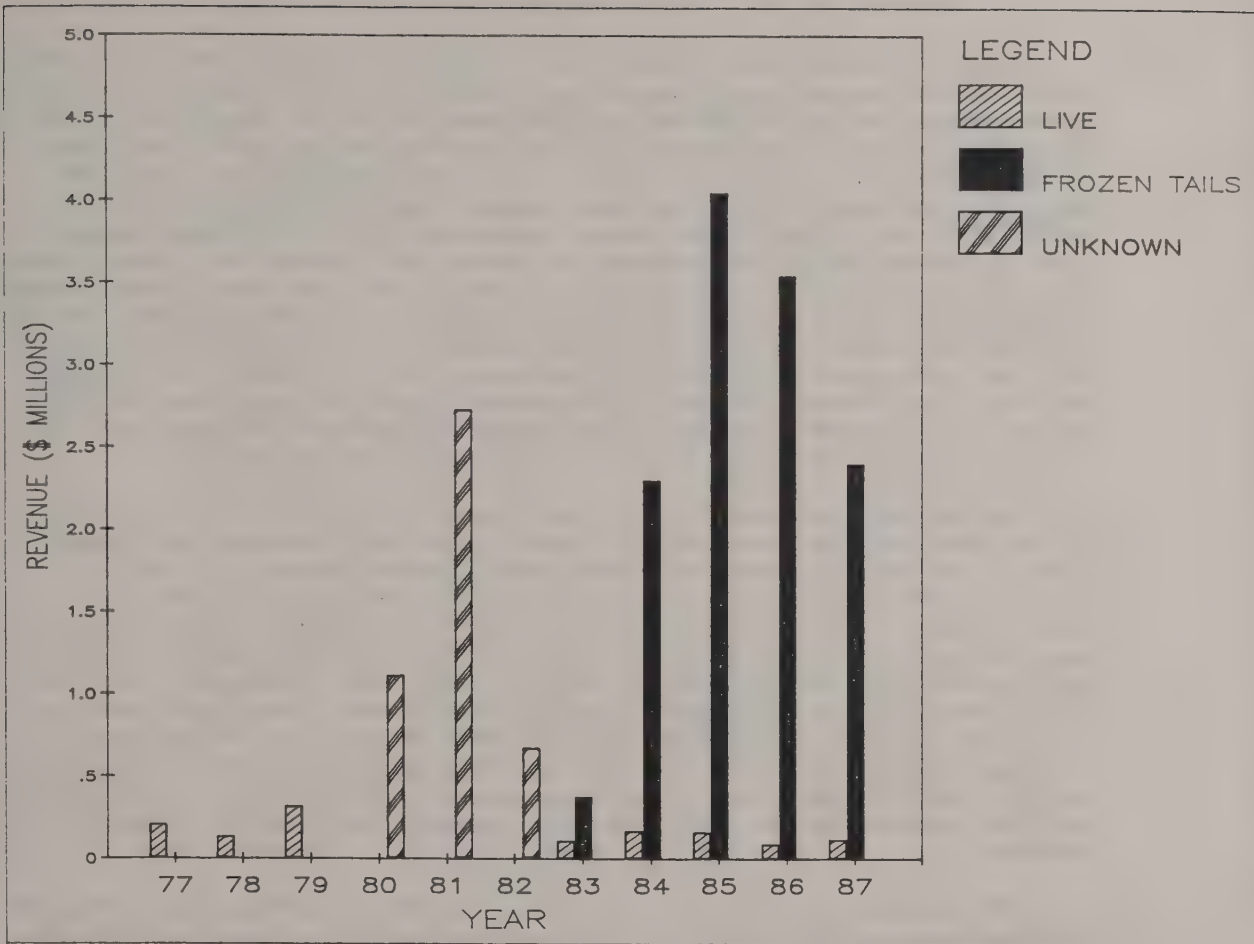


Figure 3.--Revenue of spiny lobster by product type in the Northwestern Hawaiian Islands, 1977-86 (frozen whole not shown).

Price

Price for almost all lobster product types rose significantly in 1987. The average price per pound (wet weight) for all product types was \$4.71 for spiny lobsters and \$3.59 for slipper lobsters (Table 1). In 1981-82, the predominate product type landed was live lobster, reflected by the relatively high average price per pound. The frozen whole lobster price per pound dropped during 1982-83 because vessels converted from live lobster to frozen tail production. Live lobster maximizes the dollars generated per pound of lobster caught as compared to frozen tail production. The continually increasing value of the fishery's products on a per pound basis is most clearly evident with respect to slipper lobsters. In 1983, slipper lobster landings were relatively small and were mainly in the form of frozen tails. The 1984 average price of \$1.64/lb represents the relatively low ex-vessel price paid for slipper lobster tails at the fishery's inception. By 1987, the value of slipper lobsters had increased to where the average price per pound was greater than that paid for spiny lobsters in 1986.

The dramatic increase in price per pound is even more evident when broken down into the three product types, live, whole frozen, and frozen tails. Live spiny lobster price rose only slightly during 1983-86; however, 1987 brought a substantial rise in ex-vessel price. The live spiny lobster price has increased at an approximate annual rate of 0-8% over the last 4 yr (1983-86), rising a total of only 15% during that period. Between January 1986 and December 1987, the live spiny lobster price rose 27.2%. Live slipper lobsters, which were initially a relatively low valued product, rose 35% during 1985 and 1986 but, in 1987 alone, increased 39% (Table 2). Frozen whole lobster price rose 50% for spiny lobsters and 32% for slipper lobsters; however, frozen whole lobsters were still a relatively minor contribution to overall NWHI lobster fishery landings.

The average price for spiny and slipper lobster frozen tails also rose substantially in 1987 (Fig. 4). This trend started at the end of 1986 when spiny lobster rose abruptly from approximately \$8.00/lb to over \$10.50/lb, and slipper lobster jumped from \$6.00 to \$8.00/lb. This strong rise in price continued through the first 8 mo of 1987, yielding an average price for spiny lobster frozen tails of \$13.06/lb and \$10.64/lb for slipper lobsters (Table 2).

From 1983 to 1985, frozen spiny lobster tail ex-vessel price (per pound) rose by only 10%. In 1986 alone, the price of frozen spiny lobster tails rose by 10% over the 1985 average price, and during 1986 to 1987, the average ex-vessel price of frozen spiny lobster tails rose 46%, or almost two times the rise between 1983 and 1986. Frozen slipper lobster tail price per pound has risen by more than any other lobster product produced in the NWHI lobster fishery. Between 1984 and 1985, frozen slipper lobster tails rose a healthy 31% (over 1984 price); however, in 1986 and 1987, the average price rose 65% (Fig. 4). The average price paid for frozen slipper lobster tails exceeded that paid for spiny lobster tails in 1986 by 19%.

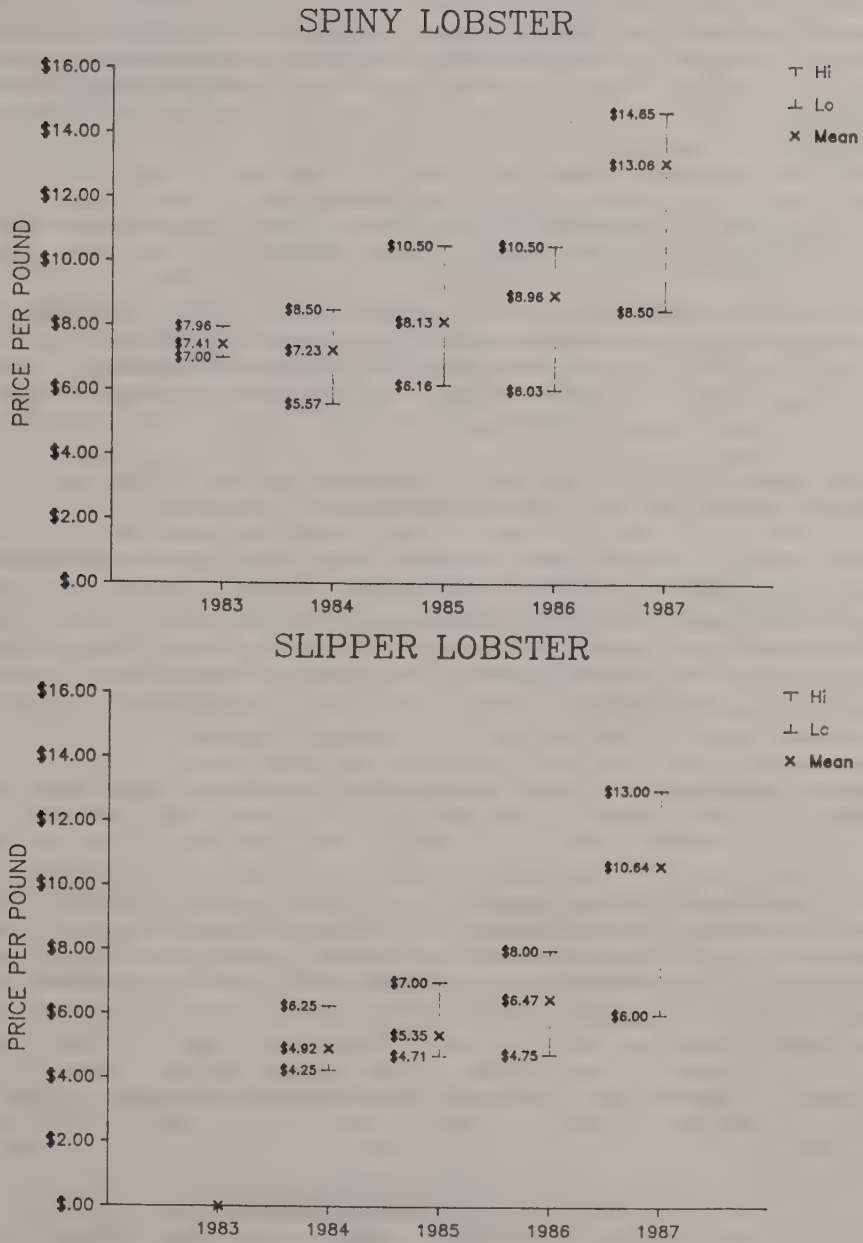


Figure 4.--Low, mean, and high ex-vessel prices of spiny lobster and slipper lobster frozen tails, 1983-87.

Two main factors are believed to be responsible for the substantial rise in ex-vessel price of frozen tails for spiny and slipper lobsters: external demand (outside the State of Hawaii) and improved quantity and quality of Hawaiian lobster products. In early 1986, spiny lobster tail production was reported by several Hawaii international wholesalers to be down in some of the traditional fisheries supplying the United States imported frozen lobster tail markets (i.e., Australia and New Zealand). Domestic (mainland U.S.) production was also on the decline (Florida's reduced landings undercut any gains made in the California fishery). Political disputes caused bans or restrictions on certain traditional suppliers (e.g., South Africa and Nicaragua) to the United States. Therefore, domestic and worldwide supplies of spiny lobsters were tight, causing increased demand for Hawaiian lobster products.

Concurrent with this increased demand, NWHI lobster fishermen were making substantial progress in product quantity and quality. The 1985-86 period brought large increases in spiny lobster landings, along with an emerging slipper lobster fishery. With the increasing volume of frozen lobster tails coming from Hawaii, buyers outside the State became acquainted with the product and found it to be a satisfactory substitute for other spiny lobster tails (Australia, New Zealand, and South Africa). As a result, Hawaiian lobsters were competitively priced.

Initial problems with production of high quality tails have been worked out, especially in the case of slipper lobsters, which were previously equated by many U.S. mainland buyers as a low quality, low valued product (Gates and Samples 1987). Buyers in Hawaii and the U.S. mainland realized that slipper lobster tails were of equal or better taste than spiny lobster tails, despite differences or shortcomings in product appearance. With increased quality and quantity, along with greater demand for lobster tails nationwide, NWHI lobster fishermen were well positioned to benefit from the substantial increases paid in ex-vessel price of their lobster products in 1987.

However, the 1988 outlook does not appear quite as bright for continued large increases in ex-vessel price. Spiny and slipper lobster landings from the NWHI dropped significantly in 1987. Marketing channels developed in the 1985-86 period "dried up" because of lack of supply. The large increase in ex-vessel price was immediately reflected in the retail sector, with Hawaiian spiny lobster tails selling for \$20.00+/lb in some mainland retail outlets. Retailers and wholesalers indicate that consumer resistance to the rapidly increasing frozen tail price caused reduced demand toward the end of 1987. Ex-vessel prices were predicted to be fairly stable for the first 6 mo of 1988.

CATCH AND EFFORT

Catch and effort statistics are derived from the Daily Lobster Catch Report per Statistical Area form which, by law, is to be filled out within the 24 h following each fishing day. Information on catch and effort are specified by each statistical area fished. Summaries of catch and effort

data by date of landing are sent to various fisheries management agencies each month. As in previous annual reports, all catch and effort statistics presented in this section are computed by using date of landing. If date of haul were used to create these periodic summaries, then potentially 3 mo could pass before complete reporting became available. The summary information presented here encompasses fishing effort from trips in which lobsters were landed in the 1987 calendar year.

Catch Composition

In 1987, there were 349,556 legal, 234,173 sublegal, and 101,560 berried spiny lobsters and 476,568 total slipper lobsters reported caught (Table 3). As in previous years, only the total number of slipper lobsters caught was reported because many fishermen did not differentiate between legal, sublegal, and berried slipper lobsters. However, with the approval and passage of Amendment 5 to the FMP, beginning January 1988, slipper lobster catches must be documented the same as spiny lobsters (i.e., legal, sublegal (<5.60-cm tail width), and berried lobsters).

In 1987, no fishing was reported by federally permitted fishermen in the FCZ of the main Hawaiian Islands (permit area 2), and no permits were issued for American Samoa and Guam (permit area 3); therefore, the information reported here deals only with the NWHI portion of the fishery (permit area 1). During 1987, 12 different banks and islands (statistical areas) were fished. Seven different statistical areas were fished by more than three different vessels, and five areas, by two or less. Federal statutes on confidentiality dictate that summary statistics can only be presented for specific areas fished by three or more vessels, so the remaining banks will be grouped into an "other" category.

In 1987, effort by area was concentrated in the same general pattern as seen in 1985 and 1986 (Table 3). The mainstay banks, Maro Reef, Necker Island, and Gardner Pinnacles, were fished by lobster vessels on 18, 12, and 8 trips, respectively. As in the previous 4 yr, catches of spiny and total slipper lobsters were greatest at Maro Reef. In 1987, Maro Reef, Necker Island, and Gardner Pinnacles, in descending order, produced the greatest number of legal spiny lobsters. The same trend holds true for total spiny lobster catches. These three banks produced 80.5% of the legal and 81.7% of the total spiny lobsters reportedly caught in the NWHI lobster fishery.

In 1987, production from the named banks did not exceed or equal the totals reported in 1986. This trend is most evident at some of the banks that came under exploitation in recent years (Table 3). In 1985 and 1986, St. Rogatien Bank was a major producer of both spiny and slipper lobsters; however, in 1987, it produced only 20.7% of the legal and 23.6% of the total spiny lobsters reported in 1986. (In 1985, St. Rogatien produced over 200,000 legal spiny lobsters and 270,000 total spiny lobsters.) French Frigate Shoals, which made a large jump in production from 1985 to 1986, dropped substantially in 1987. Legal spiny catch at French Frigate Shoals dropped to 22% of the reported 1986 level; however, sublegal catch only dropped by 19.3%.

Table 3.--Annual catch of spiny lobster and slipper lobster,
by area, in the Northwestern Hawaiian Islands, 1983-87.

Area	Vessels (No.)	Trips (No.)	Catch (in numbers)				
			Legal spiny lobster	Sublegal spiny lobster	Berried spiny lobster	Total spiny lobster	Total slipper lobster
1983							
Necker Island	4	18	111,710	48,148	8,710	168,568	13,731
Other ^a	2	3	45,896	2,632	1,002	49,530	11,878
Total	4	19	157,606	50,780	9,712	218,098	25,609
1984							
Nihoa	3	8	24,174	1,531	11,213	36,918	12,993
Necker Island	10	24	210,494	206,919	40,765	458,178	77,401
Gardner Pinnacles	5	10	174,274	9,059	5,836	189,169	109,264
Maro Reef	3	7	250,489	20,789	16,329	287,607	83,855
Other and main Hawaiian Islands ^b	2	5	7,861	181	108	8,150	1,302
Total	11	38	667,292	238,479	74,251	980,022	284,815
1985							
Necker Island	12	35	185,654	212,970	32,440	431,064	154,464
French Frigate Shoals	3	4	10,011	2,462	1,172	13,645	5,306
Brooks Banks	3	5	21,486	5,669	4,865	32,645	55,843
St. Rogatien Bank	4	7	200,054	42,308	33,954	276,316	161,030
Gardner Pinnacles	8	13	96,484	15,354	10,289	122,127	212,528
Raita Bank	4	5	9,583	644	295	10,522	5,468
Maro Reef	7	18	359,949	53,874	41,200	455,023	538,288
Lisianski Island	3	3	36	10	14	60	840
Pearl and Hermes Reef	4	6	49,960	9,659	2,252	61,871	40,466
Kure Atoll	4	5	14,159	1,057	2,021	17,237	7,396
Other and main Hawaiian Islands ^c	2	10	8,556	596	885	10,037	6,796
Total	16	62	956,042	344,611	129,403	1,430,056	1,189,842

Table 3.--Continued.

Area	Vessels (No.)	Trips (No.)	Catch (in numbers)				
			Legal spiny lobster	Sublegal spiny lobster	Berried spiny lobster	Total spiny lobster	Total slipper lobster
1986							
Nihoa Island	5	8	5,272	246	3,902	9,420	29,131
Necker Island	8	19	173,785	119,252	38,973	332,010	84,382
French Frigate Shoals	6	7	66,640	30,711	13,519	110,870	23,681
Brooks Banks	3	8	27,472	4,650	2,004	34,126	113,036
St. Rogatien Bank	3	7	117,156	21,469	9,441	148,066	90,596
Gardner Pinnacles	8	14	86,556	16,209	14,183	116,908	94,002
Raita Bank	6	8	52,039	6,430	5,572	64,041	78,948
Maro Reef	12	25	350,234	104,886	65,583	520,703	476,671
Lisianski Island	4	4	1,827	93	170	2,090	26,212
Other and main Hawaiian Islands ^d	2	4	15,426	3,918	2,217	21,561	220,868
Total	16	60	896,407	307,864	155,564	1,359,795	1,237,527
1987							
Nihoa Island	5	5	3,820	112	1,452	5,384	6,936
Necker Island	5	12	99,516	91,030	27,046	217,592	85,272
French Frigate Shoals	4	4	14,733	24,805	11,104	50,642	16,309
St. Rogatien Bank	4	7	24,269	7,101	3,615	34,985	15,115
Gardner Pinnacles	6	8	34,689	17,787	10,291	62,767	56,903
Raita Bank	4	5	5,943	605	684	7,232	13,753
Maro Bank	8	18	183,415	87,817	44,920	316,152	178,556
Other ^e	4	11	28,171	4,916	2,448	35,532	103,724
Total	11	38	394,556	234,173	101,560	730,286	476,568

^aIncludes Gardner Pinnacles and Maro Reef.

^bIncludes French Frigate Shoals and Raita Bank.

^cIncludes Midway.

^dIncludes Northampton Seamount, Pioneer Bank, Pearl and Hermes Reef, Midway, Kure Atoll, and an unnamed bank north of St. Rogatien Bank, Laysan Island.

^eIncludes Pearl and Hermes Reef, Pioneer Bank, Northampton Seamount, Lisianski Island, and Brooks Banks.

In 1987, as in 1986, the majority of slipper lobsters reportedly were caught at Maro Reef. This bank produced approximately the same proportion of the total slipper lobster catch in 1987 as 1986 (37.5% vs. 38.5%). As in 1986, the "other" category (five banks) ranked second, with approximately 22% of 1987 total slipper lobsters reported caught (Table 3). Necker Island and then Gardner Pinnacles were the third and fourth largest producers of slipper lobsters in 1987. The only bank that had more total slipper lobsters reported caught in 1987 as compared to 1986 was Necker Island, where production rose by approximately 1% (probably insignificant considering the variability of the data source). Some banks in the "other" category rose in production, while others dropped substantially, with no clear trend evident. The 1987 production for the "other" banks was approximately half of that for 1986; however, fewer banks were included in this category in 1987 (seven banks versus five).

Combined total production of spiny and total slipper lobsters at Maro Reef was 41% of the total NWHI lobster fishery production, followed by Necker Island (25.0%) and Gardner Pinnacles (9.9%). Maro Reef's contribution was approximately equal to its 1985 and 1986 levels while Necker Island's declined (Table 3). The 1987 effort by vessel trips appears to have concentrated around the main banks of Maro Reef, Necker Island, and Gardner Pinnacles. This is evinced by the reduced number of trips made to the lesser banks, indicating reduced exploration of the less frequently fished banks. The spiny lobster fishery appears to be concentrated on the historically fished banks (Maro Reef, Necker Island, Gardner Pinnacles), while some of the more recently exploited areas, which were good producers in 1985-86 (e.g., Raita Bank), appear not to have held up as well (see Polovina et al. 1988).

The contribution of the various catch categories (legal, sublegal, and berried spiny lobsters and total slipper lobsters) are presented in Figure 5. In 1987, total slipper lobsters represented 39.5% of the total NWHI lobster catch, with legal spiny lobsters following (32.7%), then sublegal (19.4%), and finally berried spiny lobsters (8.4%). The relative contribution of legal spiny lobsters was the lowest since 1983, while the total contribution of slipper lobsters dropped below 1985-86 levels (of approximately 46%). The relative contribution of sublegal lobsters rose in 1987 but was about equal to that reported in 1983. The 1987 relative contribution of berried spiny lobsters was the greatest on record. Increases in sublegal spiny lobster catches may be due to fishermen using a proportionately greater number of the smaller mesh shrimp traps in 1987. While there were a few minor changes, the overall catch composition of the NWHI lobster fishery in 1987 appears to be similar to that reported in the previous 2 yr.

Table 4 gives the relative proportion of total spiny lobsters to total slipper lobsters caught by bank for the NWHI fishery. Of the 12 banks fished in 1987, 7 had more total spiny than slipper lobsters reported caught. This represents a general reversal of the 1986 trend in which nine banks (including some of those in the 1986 "other" category) reported more total slipper than spiny lobsters caught. The 1987 results may be related to the fishing activity reconcentrating around the major proven banks and less exploration

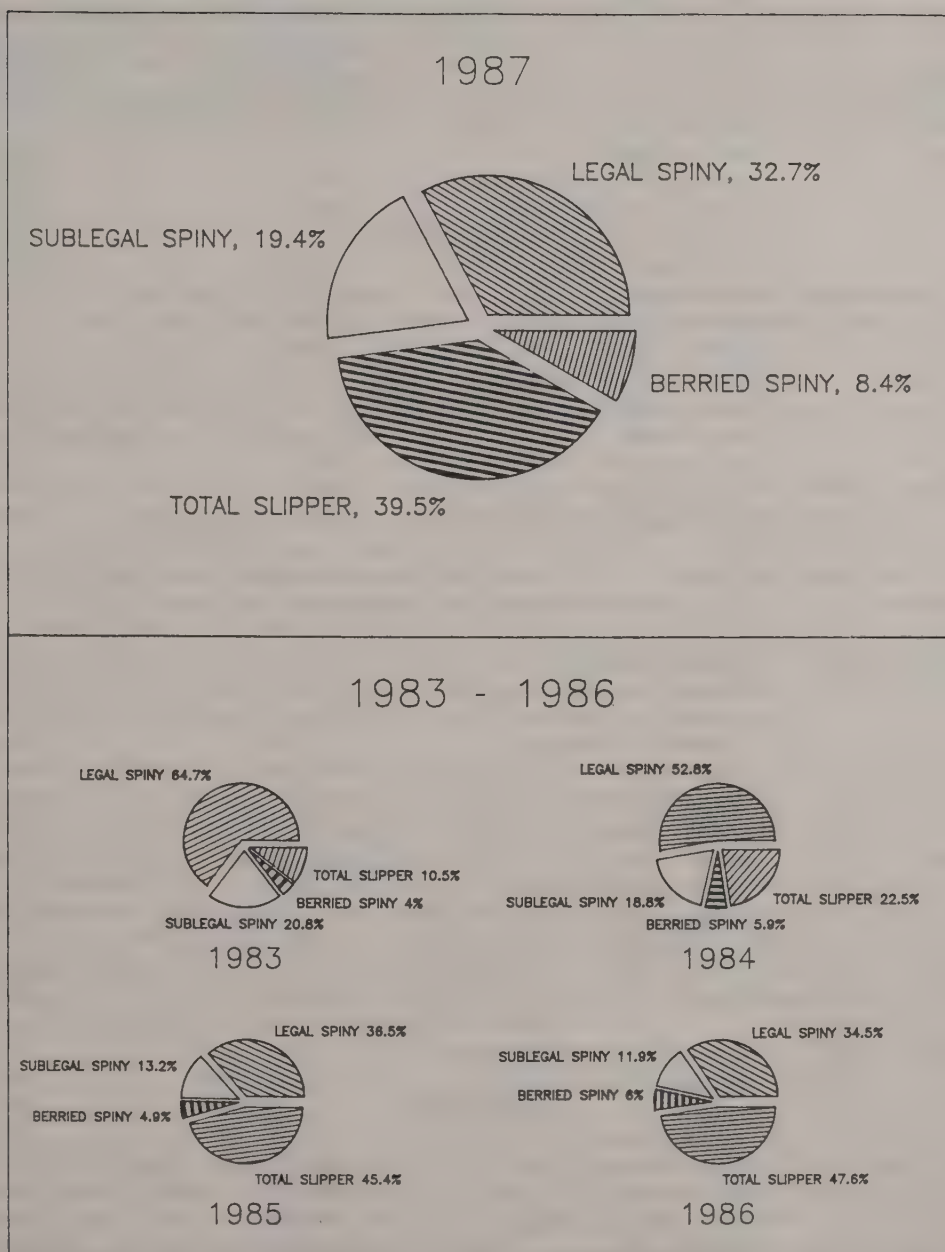


Figure 5.--Percent of the Northwestern Hawaiian Islands lobster catch by species, 1983-87.

Table 4.--Percent of total slipper lobster and spiny lobster in the catch, by bank and year, in the Northwestern Hawaiian Islands, 1985-87.

Year	Area	Total spiny lobster (%)	Total slipper lobster (%)
1985	Brooks Banks	36.4	63.6
	French Frigate Shoals	72.0	28.0
	Gardner Pinnacles	36.5	63.5
	Kure Atoll	70.0	30.0
	Lisianski Island	6.7	93.3
	Maro Reef	45.8	54.2
	Necker Island	73.6	26.4
	Nihoa Island	58.3	41.7
	Northampton Seamount	8.6	91.4
	Pearl and Hermes Reef	60.5	39.5
	Raita Bank	65.8	34.2
	St. Rogatien Bank	63.2	36.8
	Other (1)	88.6	11.4
	Main Hawaiian Islands	74.8	25.2
	Total	54.6	45.4
1986	Brooks Banks	23.2	76.8
	French Frigate Shoals	82.4	17.6
	Gardner Pinnacles	55.4	44.6
	Lisianski Island	7.4	92.6
	Maro Reef	52.2	47.8
	Necker Island	79.7	20.3
	Nihoa Island	24.4	75.6
	Raita Bank	44.8	55.2
	St. Rogatien Bank	62.0	38.0
	Other (7)	7.4	92.6
	Main Hawaiian Islands	92.6	7.4
	Total	52.4	47.6
1987	French Frigate Shoals	75.6	24.4
	Gardner Pinnacles	52.6	47.4
	Maro Reef	63.9	36.1
	Necker Island	71.8	28.2
	Nihoa Island	43.7	56.3
	Raita Bank	34.5	65.5
	St. Rogatien Bank	69.8	30.1
	Other (5)	25.5	74.5
	Total	60.5	39.5

activity by vessels than in previous years. Maro Reef produced predominately spiny lobsters (63.9%), but also had a substantial slipper lobster contribution although it was lower than the previous 2 yr. Necker Island's total slipper lobster contribution was higher than in 1986. There were no major shifts in individual species composition by area, with the overall trend showing 60.5% for total spiny lobsters and 39.5% for total slipper lobsters. The "other" category represented the most one-sided species composition in 1987, as was the case in 1986, with these banks producing mainly slipper lobsters.

Fishing Effort

The CPUE in the NWHI lobster fishery is calculated by **trap-hauls**. This unit of effort is slightly different; previous annual reports used an estimate of trap-nights fished to calculate CPUE. The reasons for this change are presented in Clarke and Todoki (in press). All CPUE numbers reported in this section are by date of landing, i.e., date of arrival in Honolulu rather than date of capture.

In 1987, there were 804,711 trap-hauls recorded by the NWHI lobster fishermen, a decrease of 40.5% from 1986 (Table 5). The trap-hauls in 1987 were also substantially less than in 1985 (983,018). In 1987, 31.3% of total NWHI trap-hauls were recorded at Maro Reef. This continues a 4-yr trend in which Maro Reef accounted for approximately 35% of all trap-hauls in the NWHI lobster fishery. (Necker Island accounted for 66% of the trap-hauls in 1983.) Following Maro Reef, Necker Island was the second leading area, with 23.5% of the total trap-hauls, followed by Gardner Pinnacles (13.0%) and the "other" category (12.0%).

Fishing activity days (days in which a vessel hauled gear from a bank) were greatest in number at Maro Reef, Necker Island, Gardner Pinnacles, the "other" category, and St. Rogatien (Table 5). In 1987, if one were to spread the total number of trap-hauls over the entire year (364 d), Maro Reef and Necker Island would average 692 and 519 trap-hauls every day. This figure dropped significantly at Maro Reef in 1987 (1986 value of 519 trap-hauls) but increased at Necker Island (579 trap-hauls). Average trap-hauls per reported day of fishing were greatest for the "other" category (814 trap-hauls at five banks), Maro Reef (724), and Gardner Pinnacles (673), and lowest at Nihoa (475) and St. Rogatien (569).

CATCH RATES

In 1987, total spiny lobster CPUE (catch per trap-haul) was 0.91, and total slipper lobster CPUE was 0.59. The CPUE's for legal, sublegal, and berried spiny lobsters were 0.49, 0.29, and 0.13, respectively. The CPUE information by area is presented in Table 5, along with revisions for 1983-86 (previous annual reports presented catch per trap-night). During 1987, Maro Reef had the highest legal spiny lobster catch rate, with Necker Island second, while Nihoa and Raita Bank had the lowest catch rates. Total slipper lobster CPUE's were highest for the "other" category, followed by Maro

Table 5.--Annual fishing effort (in trap-hauls) and catch per trap-haul for spiny lobster and slipper lobster for the 1983-87 lobster fleet in the Northwestern Hawaiian Islands. Data are from the Daily Lobster Catch Report per Statistical Area as required by the Crustacean Fishery Management Plan.

Area	Days fished (No.)	Trap- hauls (No.)	Catch (in numbers) per trap-haul				
			Legal spiny lobster	Sublegal spiny lobster	Berried spiny lobster	Total spiny lobster	Total slipper lobster
1983							
Necker Island	215	42,004	2.66	1.15	0.21	4.01	0.33
Other ^a	64	21,649	2.12	0.12	0.05	2.29	0.55
Total	279	63,653	2.48	0.80	0.15	3.43	0.40
1984							
Nihoa Island	73	21,801	1.11	0.07	0.51	1.69	0.60
Necker Island	294	94,423	2.23	2.19	0.43	4.85	0.82
Gardner Pinnacles	192	98,770	1.76	0.09	0.06	1.92	1.11
Maro Reef	247	139,531	1.80	0.15	0.12	2.06	0.60
Other ^b	16	8,478	0.93	0.02	0.01	0.96	0.15
Total	822	363,003	1.84	0.66	0.20	2.70	0.78
1985							
Necker Island	435	185,118	1.00	1.15	0.18	2.33	0.83
French Frigate Shoals	28	13,087	0.76	1.19	0.09	1.04	0.41
Brooks Banks	40	30,428	0.71	0.19	0.16	1.05	1.84
St. Rogatien Bank	213	176,370	1.13	0.24	0.19	1.57	0.91
Gardner Pinnacles	245	145,336	0.66	0.11	0.07	0.84	1.46
Raita Bank	28	10,448	0.92	0.06	0.03	1.01	0.52
Maro Bank	467	331,008	1.09	0.16	0.12	1.37	1.63
Lisianski Island	3	1,265	0.03	0.01	0.01	0.05	0.66
Pearl and Hermes Reef	104	53,712	0.93	0.18	0.04	1.15	0.75
Kure Atoll	25	15,378	0.92	0.07	0.13	1.12	0.48
Other ^c	62	19,538	0.44	0.03	0.05	0.51	0.35
Total	1,653	983,018	0.97	0.35	0.13	1.45	1.21

Table 5.--Continued.

Area	Days fished (No.)	Trap- hauls (No.)	Catch (in numbers) per trap-haul				
			Legal spiny lobster	Sublegal spiny lobster	Berried spiny lobster	Total spiny lobster	Total slipper lobster
1986							
Nihoa Island	70	28,138	0.19	0.01	0.14	0.33	1.04
Necker Island	405	210,831	0.82	0.57	0.18	1.57	0.40
French Frigate Shoals	99	61,368	1.09	0.50	0.22	1.81	0.39
Brooks Banks	131	75,326	0.36	0.06	0.03	0.45	1.50
St. Rogatien Bank	179	137,190	0.85	0.16	0.07	1.08	0.66
Gardner Pinnacles	233	168,790	0.51	0.10	0.08	0.69	0.56
Raita Bank	225	180,267	0.48	0.06	0.05	0.59	0.73
Maro Reef	670	458,559	0.76	0.23	0.14	1.14	1.04
Lisianski Island	20	14,828	0.12	0.01	0.01	0.14	1.77
Other ^d	134	89,262	0.17	0.04	0.03	0.24	2.47
Total	2,166	1,352,559	0.66	0.23	0.12	1.01	0.91
1987							
Nihoa Island	49	23,323	0.16	0.00	0.06	0.23	0.30
Necker Island	318	188,823	0.53	0.48	0.14	1.15	0.45
French Frigate Shoals	62	42,045	0.35	0.59	0.26	1.20	0.39
St. Rogatien Bank	117	66,602	0.36	0.11	0.05	0.53	0.23
Gardner Pinnacles	156	105,130	0.33	0.17	0.10	0.60	0.54
Raita Bank	48	29,950	0.20	0.02	0.02	0.24	0.46
Maro Reef	348	251,970	0.73	0.35	0.18	1.25	0.71
Other ^e	119	96,868	0.29	0.05	0.03	0.37	1.07
Total	1,217	804,711	0.49	0.29	0.13	0.91	0.59

^aIncludes Gardner Pinnacles and Maro Reef.

^bIncludes French Frigate Shoals, Raita Bank, and the main Hawaiian Islands.

^cIncludes the main Hawaiian Islands and Midway.

^dIncludes Northampton Seamount, Pioneer Bank, Pearl and Hermes Reef, Midway, Kure Atoll, an unnamed bank north of St. Rogatien Bank, Laysan Island, and the main Hawaiian Islands.

^eIncludes Pearl and Hermes Reef, Pioneer Bank, Lisianski Island, Northampton Seamount, and Brooks Banks.

Reef, then Gardner Pinnacles (Fig. 6). The lowest slipper lobster CPUE's were recorded for St. Rogatien Bank and Nihoa (Fig. 7). Combining the legal spiny lobster catch rate with the total slipper catch rate, Maro Reef ranks first at 1.44 lobsters per trap-haul, the "other" category second (1.36), and Necker Island (0.98). The lowest combined lobster catch rates were recorded at Nihoa (0.46) and St. Rogatien Bank (0.59).

The combined CPUE (legal spiny and total slipper lobsters) declined by 29% in 1987 from 1986 levels for all 12 banks combined. Legal spiny and total slipper lobster CPUE's declined to 72 and 69% of their respective 1986 levels. The 1987 CPUE figures for legal and total spiny lobsters show a 25.8 and 9.9% drop from revised 1986 CPUE figures (Table 5). The sublegal spiny lobster catch rate actually rose by 26%, while berried spiny lobster catch rate stayed approximately the same as in 1986. Slipper lobster CPUE declined by 35.2% from 1986 revised CPUE figures. While the CPUE data are thought to represent relative trends, they should be viewed with caution. The 1987 increase of sublegal spiny lobster CPUE over the 1986 catch rate appears initially to be substantial; however, it may be due to the use of proportionately more traps with smaller mesh. Despite the drawbacks in relying on the absolute values of the CPUE information, it appears that Maro Reef continues to produce well for NWHI lobster fishermen, although at a reduced rate from previous years. In addition, despite excessive effort at Necker Island (Polovina et al. 1988), the area continues to maintain its relative production position of the last 5 yr. Some of the secondary banks appear to not have held up as well to exploitation as the major banks. St. Rogatien is a specific example; it had the best spiny lobster CPUE of all the banks in 1985 but now ranks toward the lower half of the list. Raita Bank had the largest decline in trap-hauls, with a 72% decrease in effort in 1987.

Total numbers of reported fishing days dropped by 43.8% overall for the fleet in 1987 from 1986 (Table 5). Raita Bank and Maro Reef experienced the greatest decline in fishing days, 78.6 and 48.0%, respectively. The average number of trap-hauls per day of fishing rose from 625 per day in 1986 to 661 in 1987; however, this increase in trap-hauls represents a leveling off after the dramatic increase in fishing intensity seen in the last 3 yr (Fig. 8).

Monthly CPUE figures for spiny and slipper lobsters, as calculated using date of landing, are presented in Table 6. Legal and total spiny lobster CPUE's in 1987 were highest in August (0.86 and 1.50). The lowest catch rates for legal spiny lobsters were recorded in April and May. Total slipper lobster CPUE was highest in April, lowest in February, and rose again in August. These figures have inherent lags due to the effect of trip lengths over 1 mo.

Caveats about the commercial CPUE data are discussed in Clarke et al. (1987), Polovina et al. (1988), and Clarke and Todoki (in press). The NWHI lobster CPUE data are reported without any targeting information, and specific species interpretation prove difficult. Combining legal spiny lobster and total slipper lobster catch may give a more accurate picture because effort expended is directed at total catch. However, not all of the

Legal Spiny Lobster

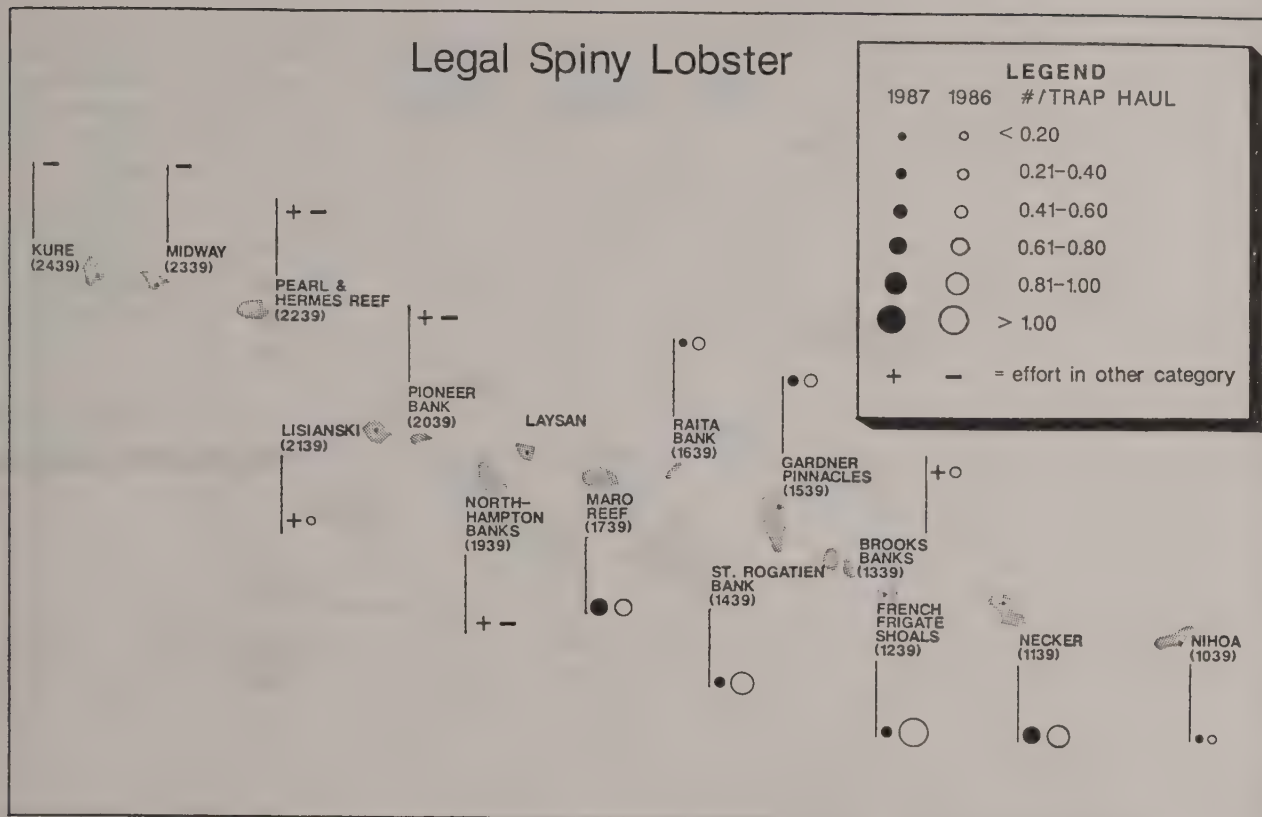


Figure 6.--Legal spiny lobster catch per trap-haul by bank in the Northwestern Hawaiian Islands, 1986-87.

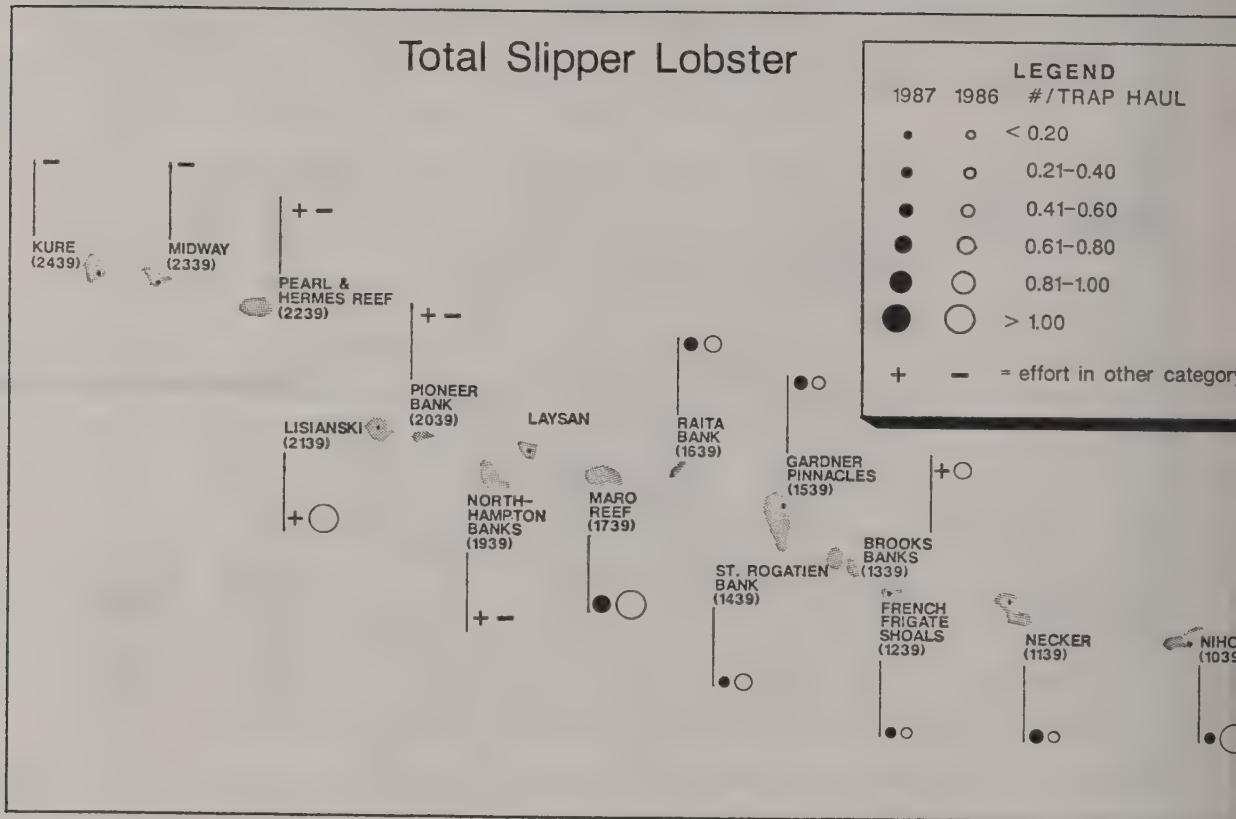


Figure 7.--Total slipper lobster catch per trap-haul by bank, 1986-87.

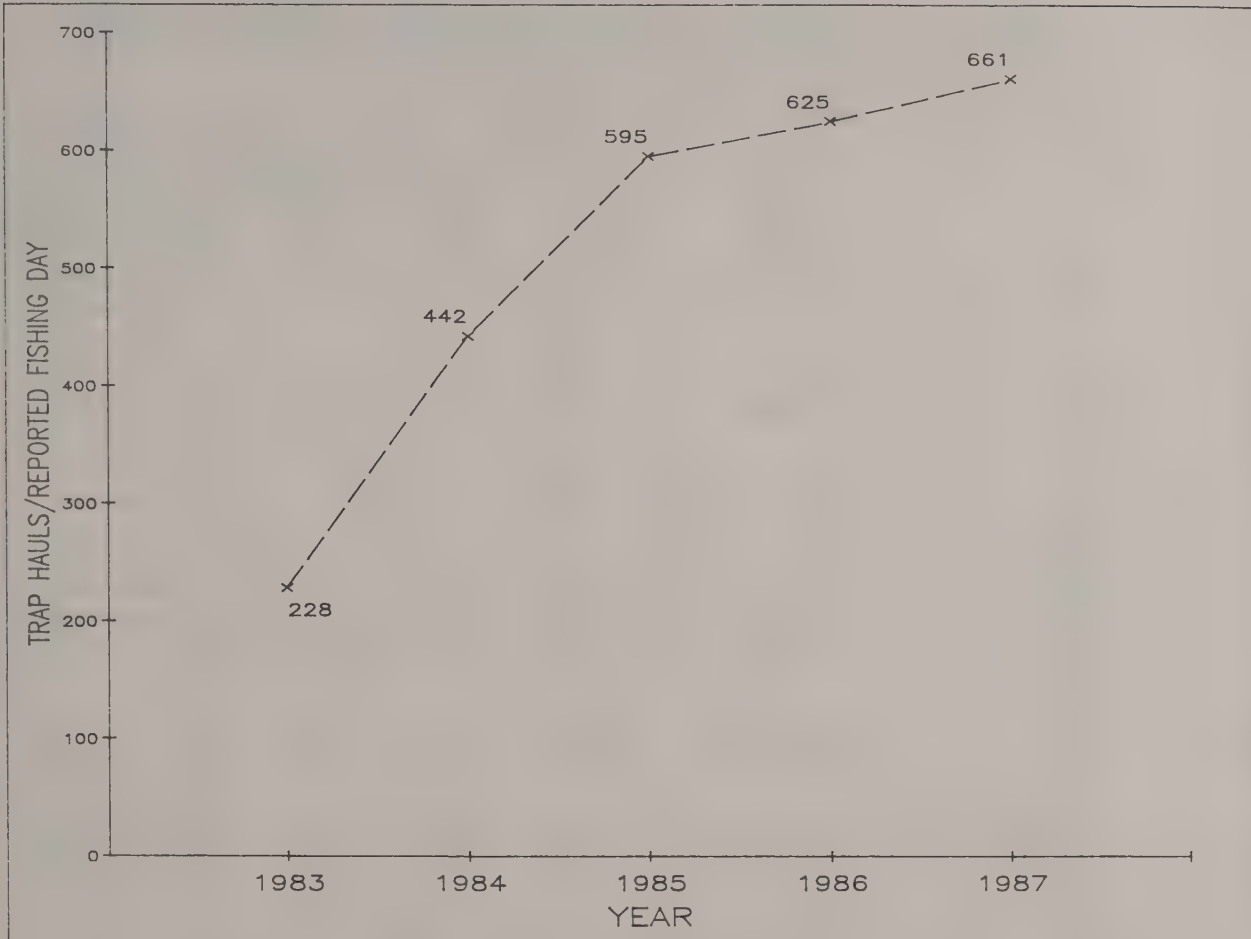


Figure 8.--Trap-hauls per fishing day as reported for the lobster fishery in the Northwestern Hawaiian Islands, 1983-87.

Table 6.--Monthly catch per trap-haul of spiny lobster and slipper lobster for the lobster fleet in the Northwestern Hawaiian Islands, 1983-87. Data are from the Daily Catch Report per Statistical Area as required by the Crustacean Fishery Management Plan.

Date	Areas	Trap-hauls (No.)	Catch (in numbers) per trap-haul				
			Legal spiny lobster	Sublegal spiny lobster	Berried spiny lobster	Total spiny lobster	Total slipper lobster
1983							
Total	3	63,653	2.48	0.80	0.15	3.43	0.40
1984							
January ^a							
February ^b							
March	3	13,598	2.95	1.31	0.20	4.45	1.18
April	4	52,706	1.81	0.16	0.15	2.12	0.75
May ^a							
June ^b							
July	2	10,090	0.96	0.04	0.63	1.63	0.35
August	5	66,035	2.30	0.72	0.17	3.19	0.50
September	2	14,181	2.01	2.90	0.19	5.11	1.04
October ^b							
November	4	42,981	1.76	0.60	0.13	2.48	0.98
December	6	121,279	1.56	0.52	0.23	2.32	0.92
Total	7	363,003	1.84	0.66	0.20	2.70	0.78
1985							
January	3	16,278	0.89	0.26	0.10	1.25	0.34
February	3	22,911	0.92	1.24	0.21	2.36	0.78
March	6	45,612	0.97	0.66	0.09	1.72	1.05
April	10	118,454	0.48	0.14	0.04	0.66	1.69
May	9	47,891	0.64	0.58	0.10	1.33	1.99
June	5	115,073	0.77	0.32	0.12	1.20	2.70
July	4	108,714	1.25	0.18	0.19	1.62	1.13
August	10	94,942	1.13	0.42	0.19	1.73	0.67
September	9	45,351	1.69	0.72	0.22	2.62	0.40
October	9	168,669	1.15	0.27	0.19	1.61	0.80
November ^b							
December	8	167,793	0.90	0.35	0.08	1.33	0.89
Total	18	983,018	0.97	0.35	0.13	1.45	1.21

Table 6.--Continued.

		Catch (in numbers) per trap-haul					
Date	Areas	Trap-hauls (No.)	Legal spiny lobster	Sublegal spiny lobster	Berried spiny lobster	Total spiny lobster	Total slipper lobster
1986							
January	6	101,876	0.87	0.33	0.07	1.27	0.69
February	7	20,937	0.43	0.34	0.08	0.86	1.17
March	3	18,650	0.92	0.58	0.17	1.67	0.46
April	11	165,150	0.58	0.23	0.08	0.88	1.37
May	4	56,913	0.27	0.25	0.10	0.62	1.07
June	6	102,103	0.36	0.16	0.10	0.61	1.52
July	12	152,035	0.42	0.06	0.12	0.61	1.69
August	9	167,534	0.71	0.14	0.10	0.95	0.70
September	3	107,314	1.22	0.38	0.18	1.78	0.38
October	3	77,410	0.65	0.24	0.20	1.08	0.54
November	6	237,316	0.83	0.25	0.10	1.18	0.68
December	8	145,321	0.51	0.25	0.14	0.90	0.51
Total	19	1,352,559	0.66	0.23	0.12	1.01	0.91
1987							
January ^b							
February ^b							
March	4	99,563	0.50	0.20	0.05	0.75	0.54
April ^b							
May	5	23,400	0.09	0.24	0.07	0.40	0.61
June	5	104,820	0.27	0.20	0.11	0.58	0.54
July	3	45,787	0.52	0.27	0.13	0.91	0.29
August	8	144,623	0.86	0.39	0.26	1.50	0.88
September ^b							
October	7	74,680	0.51	0.16	0.11	0.78	0.36
November ^b							
December	8	173,510	0.34	0.34	0.09	0.76	0.68
Total	12	804,711	0.49	0.29	0.13	0.91	0.59

^aNo landings.^bConfidential data.

slipper lobsters reported caught are retained. In addition, ridgeback slipper lobsters are not included in the slipper lobster CPUE when reported separately on log sheets. In 1987, several vessels reportedly expended effort targeting ridgeback slipper lobsters (see section on recent developments). In addition to the targeting practice is the problem of changing gear types. During 1987, more and more of the smaller (2 x 2 in) mesh traps were replaced by smaller (1 x 2 in) shrimp type traps. This may have caused the increased capture of sublegal spiny lobsters. Additional perturbations in the analysis are expected in 1988 with the introduction of escape vented gear, which in theory will reduce sublegal capture of both spiny and slipper lobsters. For the first time since 1983, complete CPUE information will be collected on slipper lobsters with the enactment of a legal size and its incorporation into the Crustacean FPM.

Seasonal Pattern

Seasonal patterns of effort appeared to be similar to those in previous years; however, large landings of slipper lobsters were not recorded in the spring of the year, as had happened in the previous years (Fig. 9). Slipper lobster catches appeared to be incidental to spiny lobster effort for much of 1987. However, in late 1987, several vessels reportedly targeted slipper lobster for both the live and frozen tail markets. Spiny lobster effort was steady throughout the first 6 mo of 1987, but overall effort (in trap-hauls) was substantially less than in previous years and by a different class of vessels (predominately Class III). By June, almost all vessels were active, and spiny lobster catches were relatively good.

Catch per trap-haul is used for CPUE in Figure 9; this is in contrast to last year's annual report (Clarke et al. 1987) in which catch per trap-night was depicted. Interpretation of CPUE data for each species proves difficult in lieu of any information on targeting; however, the combined CPUE of legal spiny and total slipper lobsters is shown in Figure 10. With the movement of spiny and slipper lobster stocks toward equilibrium conditions, seasonal trends, if any, will become more apparent in the future.

Vessel Operational Performance

Sea days are reported in adjusted and unadjusted modes for 1987 in Table 7. The adjusted 1987 fleet class configuration shows two Class I vessels, three Class II, and four Class III vessels. Two vessels that fished in 1987 are classified as Class 0 vessels. For a description of vessel classes and sea day analysis, see Clarke and Pooley (in press).

In 1987, the average NWHI lobster vessel took 4.3 trips, down slightly from the 1985-86 average of 4.6. Average overall trip duration of 46 d was approximately equal to the 1986 average of 45 d. Total sea days for each vessel (fleet mean) was 201 d, with fishing days (152) accounting for 75.6% of trip duration. Running days (33) accounted for 16.3% of trip duration while traveling days (6.3) accounted for 3.1%. Inclement weather days (4) were 2% of trip duration, the greatest on record since 1983.

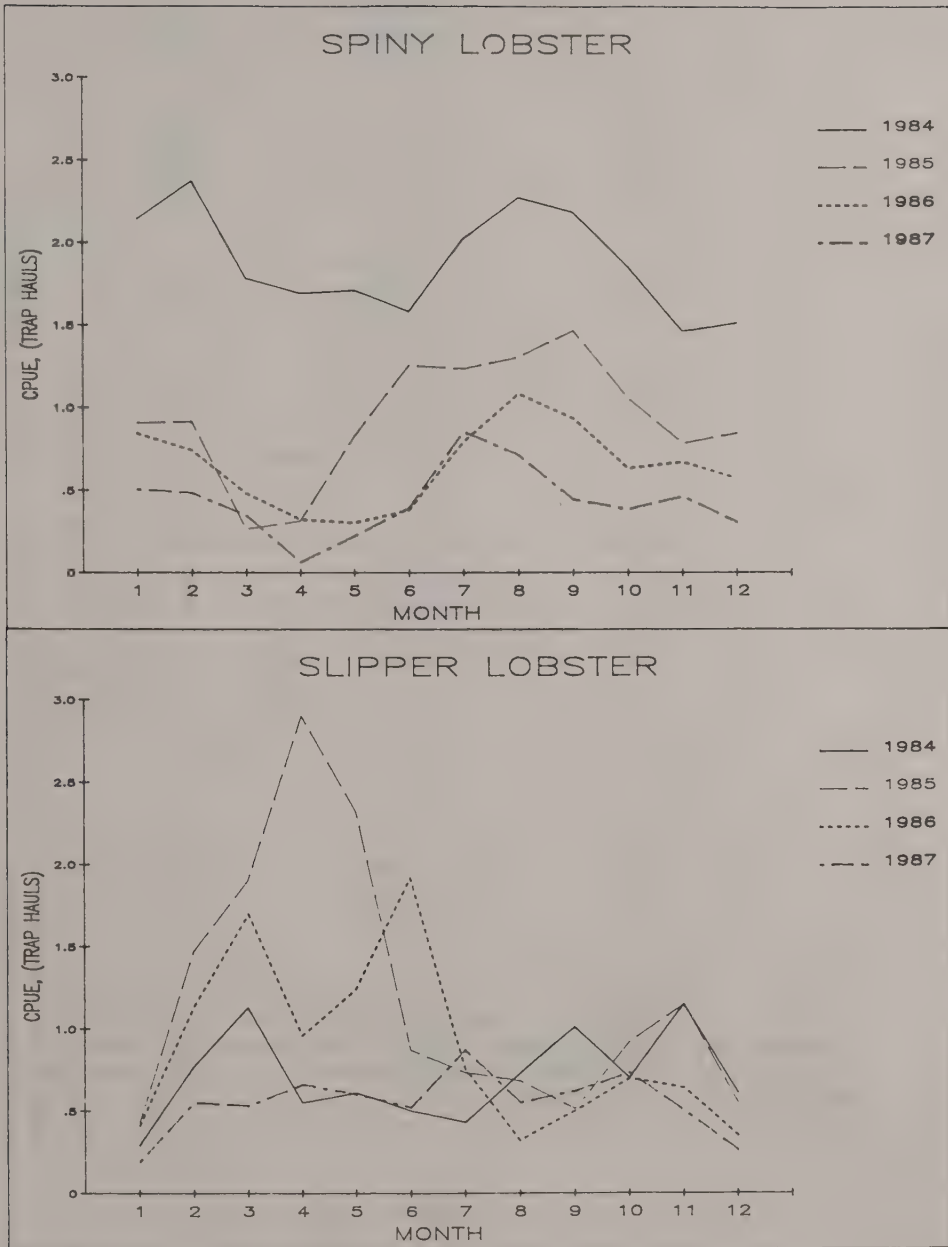


Figure 9.--Catch per trap-haul of legal spiny lobster and total slipper lobster, calculated by using date of haul, for the lobster fishery in the Northwestern Hawaiian Islands, 1984-87.

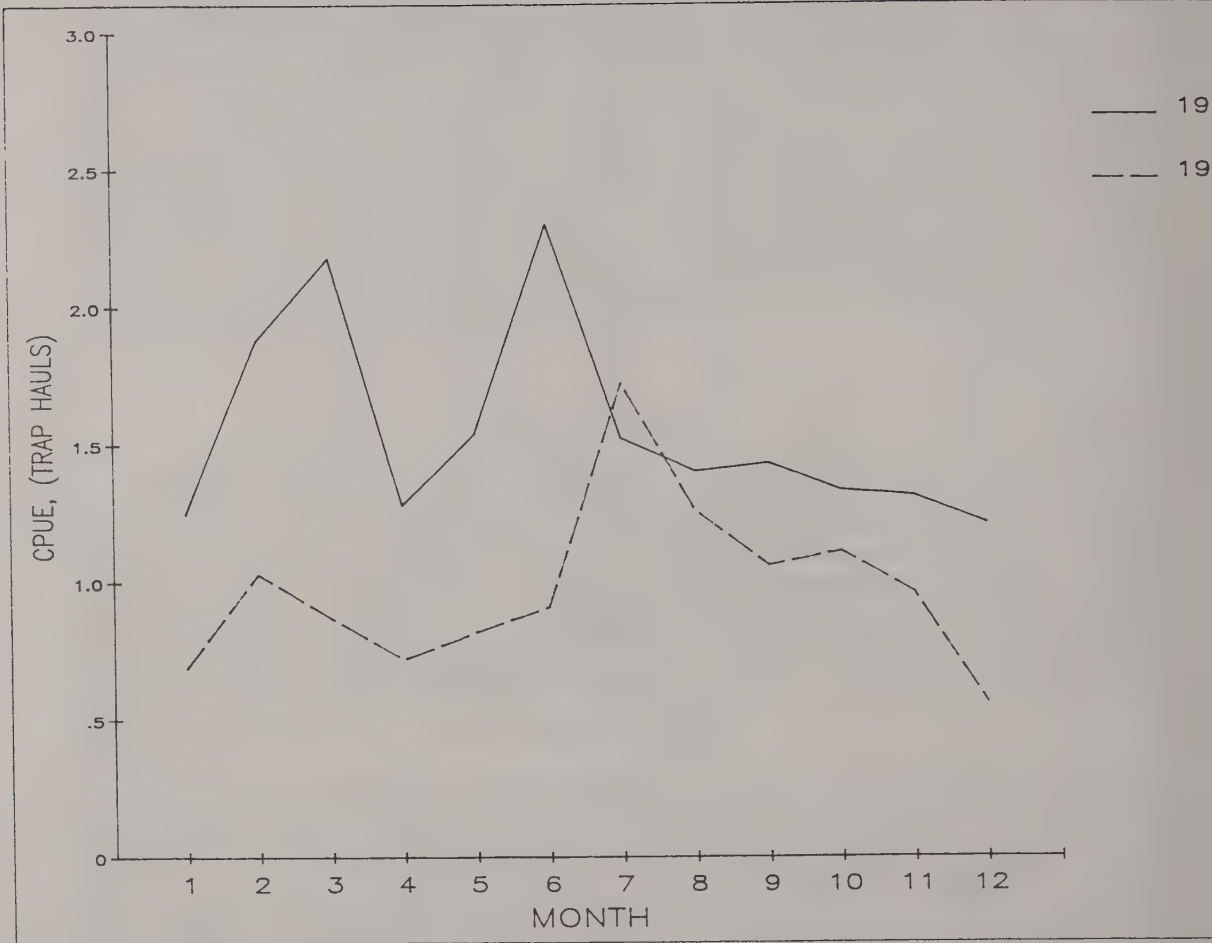


Figure 10.--Catch per trap-haul of combined legal spiny lobster and total slipper lobster, calculated by using date of haul, for the lobster fishery in the Northwestern Hawaiian Islands, 1984-87.

Table 7.--Annualized mean number of sea days and standard deviations (in parentheses), by vessel class, for the lobster fleet in the Northwestern Hawaiian Islands in 1987. Class I data are not reported because of reasons of confidentiality.

Vessel class	Vessels (No.)	$\bar{x}$	Sea days (No.)	Mean number of sea days by activity									
				Days fishing	Days traveling	Days weather	Days breakdown	Days rest/ deck work	Days missing				
Unadjusted													
1	2	—	—	—	—	—	—	—	—	—	—		
2	3	189.0	(30.5)	146.3	(16.1)	5.7	(4.5)	24.0	(7.9)	7.3	(13.0)	0.3	(0.6)
3	5	142.0	(75.7)	107.0	(62.8)	4.0	(4.3)	22.6	(13.6)	3.8	(4.1)	1.2	(2.2)
Total fleet	10	157.2	(60.7)	119.5	(51.3)	4.5	(3.8)	23.6	(10.1)	4.3	(7.0)	0.9	(1.6)
Adjusted													
1	2	—	—	—	—	—	—	—	—	—	—	—	—
2	3	218.3	(47.8)	172.0	(52.4)	6.7	(4.9)	26.7	(3.5)	7.3	(13.0)	0.3	(0.6)
3	4	188.5	(35.7)	142.0	(27.8)	5.8	(4.0)	33.3	(15.5)	2.8	(2.8)	1.5	(2.4)
Total fleet	9	200.8	(35.4)	152.1	(35.4)	6.3	(4.3)	32.7	(14.7)	3.9	(7.1)	1.2	(1.9)

Data are limited to Class II and III vessels because only two Class I and two Class 0 vessels participated in the fishery in 1987. Class II vessels had a significantly greater number of sea days than did Class III vessels. In 1987, average trip duration and fishing days were greater for Class II than Class III vessels. Surprisingly, Class II vessels recorded more weather days compared to Class III vessels, in contrast to earlier years. But in 1987, weather and sea conditions in the winter and spring were poor according to the fishermen. While minor differences occurred from previous years (1985-86), the operational patterns of the NWHI lobster fleet appear not to have changed significantly in 1987.

On a daily basis, NWHI vessels averaged 644 trap-hauls, with an average maximum number of 721 trap-hauls. Class II vessels continued to haul much more gear than Class III (767 vs. 547). The ratio of average trap-haul per day to maximum number of trap-hauls, an indicator of how often a vessel turned over all its gear, was greater for Class II vessels (0.94) than for Class III (0.86). The fleet average for 1987 was 0.89, indicating Class II vessels continue to outperform the fleet with respect to gear turnover, an important factor in operations and production.

RECENT DEVELOPMENTS

For the first time since 1982, the NWHI lobster fishery experienced significant declines in participation, effort, and total landings. Along with the contraction in fishing effort was a change in fleet configuration. The combination of reduced effort and declining CPUE caused reduced lobster landings in 1987, but ex-vessel prices rose substantially. The targeting practices of fishermen deviated slightly from those in the previous 3 yr, with more effort directed at catching ridgeback slipper lobsters.

After rapid expansion during 1984-85, participation in the NWHI lobster fishery leveled out at 15 vessels in 1986 (Table 8). At the beginning of 1986, a large segment of the large Class I vessels participating in the fishery departed for the west coast. Most of the remaining vessels were Class II and III vessels, which are physically smaller than the Class I vessels and have slightly different targeting practices.

The data on the duration of participation of vessels in the NWHI lobster fishery suggest a "maturation" of the fishery. Most of the vessels active in 1987 had been active in previous years. Seven of the lobster fishing vessels active in 1987 had fished in 1986, and only three vessels began fishing the NWHI in 1987. Eight vessels that had been active in 1986 did not fish in 1987 (excluding two vessels that fished for only 1 mo in 1987).

In 1987, 38 trips were logged by the entire NWHI lobster fleet, but a surprising number of trips (6) were aborted early because of mechanical failure or breakdown. Two breakdowns were severe enough that vessels had to be towed from the fishing grounds to Honolulu.

In the first 6 mo of 1987, the fishery experienced rising ex-vessel prices as well as a strong demand for slipper and spiny lobster tails.

Table 8.--Entry and exit patterns of individual lobster fishing vessels in the Northwestern Hawaiian Islands, 1983-87. Vessels are coded for purposes of confidentiality.

Vessel code	Entry and exit by month				
	1983	1984	1985	1986	1987
	JEMAMJJASOND	JEMAMJJASOND	JEMAMJJASOND	JEMAMJJASOND	JEMAMJJASOND
Class I					
A		XXXXXXXXXXXX	XXXXXXXXXXXX		
B			XXXXXXXXXXXX	XXXXXXXXXXXX	
C		XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	
D			XXXXXXXXXXXX	XXXXXXXXXXXX	
E			XXXX		
F				XXXXXXXX	
G				XXXXXXXXXX	XXXXXXXXXXXX
H				XXXXXXXXXXXX	X
I					XXXX
Class II					
A	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX		
B	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX
C		XXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX
D					XXXXXXXX
Class III					
A	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX
B		XXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXXXXXXXX
C		XXX	XXXXXXXXXXXX	XXXXXXXXXXXX	
D		XX	XXXXXXXXXXXX	XX	
E			XXXXXXXXXXXX	XXXXXXXXXXXX	X
F			XXXXXXX		
G			XXXXXXX	XXXXXXXXXXXX	XXXXXXX
H				XXXXXX	XXXXXXXXXXXX
I					XXXXXXX

Demand was so strong that vessels sold their loads immediately upon arrival in Honolulu and did not have to deal with any of the handling costs or logistics experienced in the previous 2 yr. But by late fall, demand slackened, and prices stabilized. Vessels had to store their product until acceptable negotiations could be worked out with wholesalers. Wholesalers reported reduced demand and consumer resistance due to the rapidly increasing lobster prices. Wholesalers and seafood brokers reported that the

worldwide financial problems associated with the October stock market crash caused uncertainty in the luxury seafood market, with restaurants and retailers unwilling to buy substantial amounts of the product because of uncertainty in lobster price direction.

In 1987, landings of ridgeback slipper lobsters increased from <5% of the total slipper lobster reported weight to over 9% (estimated). In 1987, 13,524 total ridgeback slipper lobsters were reported caught, up significantly from the 858 in 1986. Observations at sea and at dockside by NMFS personnel indicate that ridgeback slipper lobsters were underreported in both years. Unpublished NMFS data show that ridgeback slipper lobsters have a mean whole weight of 2.97 lb ($N = 288$) and a mean tail weight of 1.09 lb, or ≥ 17 oz, yielding a recovery rate of 37%. The 1987 reported catch of ridgeback slipper lobsters would potentially yield 40,166 lb of live product or 14,741 lb of frozen tails. At \$7.50/lb for live product and \$10.00/lb for tails, the value of the 1987 reported catch would be between \$140,000 and \$280,000. This reported value could be considered the lower limit for 1987, with the upper limit approaching \$400,000, taking into account unreported or misreported (as common slipper lobsters) catches and landings.

Many of the fishermen have been voluntarily reporting ridgeback slipper lobsters on their daily catch report, which will aid in assessment of the fishery. According to the fishermen, ridgeback slipper lobsters are caught or targeted in water slightly deeper (40-70 fathoms) than are common slipper lobsters (10-40 fathoms). Catch rates of more than one animal per trap-haul (for 800-1,000 trap-hauls) are seldom, unlike catch rates for common slipper lobsters. The large size of the animal yields a large tail, which traditionally has been devalued and sold as "lobster meat" or lobster base products. However, the taste appears to be very similar to common slipper and has been increasing in consumer acceptance. Fishermen report that live ridgeback slipper lobsters usually are sold for the same price as common slipper lobsters when landed alive but, because of their large size, are marked down slightly when landed frozen.

RESEARCH

Biological Assessment

In 1987, the Honolulu Laboratory conducted the third annual lobster assessment survey to determine the status of the lobster stocks in the NWHI. Research data from that and previous surveys, along with commercial logbook data, were used in the assessment, which is documented in Polovina et al. (1988). Most of the information presented here has been gleaned from that report.

Commercial catch and effort data were used in the study to document declining CPUE at 12 banks fished in both 1986 and 1987. Combined legal spiny and total slipper lobster CPUE's by area show an overall decline of approximately 29% from 1986 to 1987. Total effort, in trap-hauls, increased in 1983-85, leveled off in 1985-86, and dropped in 1987.

According to research cruise data from standardized traps and survey sites at Maro Reef and Necker Island, the CPUE of legal spiny lobsters (minimum size >5.0-cm tail width) has declined substantially since 1977, while the CPUE of spiny lobsters <5.0-cm tail width (sublegals or recruits) has remained relatively unchanged. This indicates that, although exploitation of legal-sized animals appears heavy, recruitment of spiny lobsters appears good.

Recruitment at Maro Reef and Necker Island of spiny and slipper lobsters appears healthy, but there are indications that this may not be the case for other banks. Some of the more recently exploited banks, such as Raita Bank, show a relatively low abundance of sublegal spiny lobsters. Low abundance, in conjunction with substantial declines in total spiny lobster catch and CPUE after relatively short periods of exploitation, may be preliminary indications of relatively poor recruitment or recruitment differences at certain banks (Raita, St. Rogatien, and Brooks Banks) within the NWHI chain. This situation presents interesting questions concerning their biology and proper management.

The proportion of female spiny lobsters (by tail width class) with the presence of external eggs is used to estimate the size at which females first reproduce. A reduction in the size at the onset of reproduction is one of the potential responses shown by populations under heavy exploitation. This reduction in size is shown to have taken place at both Maro Reef and Necker Island between 1977 and 1987. Spawning stock biomass in 1987 was estimated to be 33 and 81% of unexploited levels (1977) at Necker Island and Maro Reef, respectively. Slipper lobster sampling on each research cruise has been relatively small; however, the combined data set provides information that leads to the conclusion that the onset of egg production occurs well below the new minimum size of 5.6 cm but should be monitored closely.

A dynamic production model (Schnute 1977) was fit to 1983-87 data on catch and landings for Necker Island, Maro Reef, Gardner Pinnacles, and the entire NWHI lobster fishery. The model is shown to fit relatively well, and forecasts for 1988 are made based on the previous 4 yr of commercial data.

The model predicts that, even if the 1988 effort level (in trap-hauls) is equal to that of 1987, the 1988 combined lobster catch will be lower than that in 1987 for the entire NWHI lobster fishery. With the compounding effects of the enactment of a slipper lobster minimum size, combined CPUE is predicted to drop in 1988. The expected immediate effect of the slipper lobster size regulation is a 10-15% decline in slipper lobster landings. In addition to this mandated decline, a biological or stock decline is also expected. This decline, in terms of either CPUE or total landings (assuming that effort is held constant), is predicted to be approximately 19%. The effects on an individual basis depend on what type of lobster the vessel targets and where the vessel fishes. Finally, the predictions should be viewed with caution because of the relatively small data base (4 yr of data) and because they are the results of an untested model.

In 1988, the NWHI lobster fishery appears not to be showing the effects of recruitment failure and instead is showing the effects of intensive fishing from the previous 3 yr. Slipper lobster catch and CPUE in 1987 declined

significantly, as was predicted in 1986. Effort in 1986 was excessive to maintain combined catch rates (1.57) into 1987. The decline in CPUE at certain banks in 1987 was substantially greater than expected and will be monitored closely. As mentioned earlier, the model employed predicts that, if effort (in trap-hauls) remains unchanged from 1987 levels, CPUE will decline by 19%, including effects of the new minimum size regulation for slipper lobsters. Long-term maximum sustainable yield (MSY) of 716,000 legal spiny and slipper lobsters from 500,000 trap-hauls appears optimum for the fishery at this time.

Economic Research

Continuing a research initiative started in 1986, a cooperative research project on the economics of commercial lobster fishing in the NWHI was the focus of several reports in 1987. The initial area of research involved four subparts: 1) a report on the dynamics and fishing patterns in the NWHI lobster fishery, 2) a survey of wholesale lobster dealers and brokers in the mainland United States, 3) a cost-earnings study of the commercial fishing sector, and 4) a report on the potential economic effects of limited entry management. The first two items were completed in 1986 and have been reviewed in Clarke et al. (1987). Parts 3 and 4 were completed in 1987 and are reviewed herein.

The cost-earnings study is documented in Clarke and Pooley (in press), while the limited entry study is presented in Samples and Sproul (1987). The cost-earnings study reports on the economic and operational performance of three classes of lobster vessels fishing in the NWHI. Operational information came from logbook catch and effort data and from observations by samplers at dockside and at sea. The economic information was supplied by 12 vessels active during the 1985-86 season. Analysis shows that only the Class II, mid-sized vessels were profitable on average, while the larger Class I vessels faced a variety of cost constraints, and the Class III vessels faced a number of operational problems. Average return on investment was estimated to be -4.0, 36.0, and -8.5% for Classes I-III, respectively. Sensitivity analysis was conducted on a variety of factors, such as trip limitations and CPUE declines. Much of the data base, such as the operational analysis (i.e., sea days), used in the cost-earnings report, has been incorporated into the NMFS data base and will be kept current to aid in future monitoring of the NWHI active fleet.

The limited entry study initially reviewed economic theory behind access limitation, drawing on experiences in the American lobster fishery off Maine, as well as the Australian rock lobster fishery. Using cost-earnings data presented in the Clarke and Pooley (in press) study and an NMFS data base on operating characteristics as well as documented catch, revenue, and effort, data fleet profitability was estimated for four types of fleets: the composite fleet described in Clarke and Pooley (in press) and three subfleets composed of only Class I, II, and III vessels. Distinctions are drawn between operating and economic profit; the authors chose the latter as the more relevant for economic evaluation of management alternatives. Using conditions of reduced slipper lobster landings (half of 1986

landings) and 1986 spiny lobster landings as a proxy for MSY conditions, total economic profit for the fleet configuration similar to that of the 1986 fleet was determined to be -\$30,000. Potential gains through a limited entry program that controls aggregate effort and the class of vessels allowed to fish were found to potentially yield economic profits of \$2.3 million. This figure set a maximum or upper limit of the potential benefits of a limited entry program, while not accounting for management, administration, or enforcement costs, as well as social disruptions, caused by the management measure. In light of recently revised MSY figures (Polovina et al. 1988), potential gains are more likely to be substantially less than the reported upper limit.

Other

Two other studies were documented in 1987. The work done on the escape vents was summarized in Polovina et al. (in press) and the decline in size at onset of sexual maturity of spiny lobster in the NWHI is reported in Polovina.¹

ECONOMIC ANALYSIS

A comprehensive study (Clarke and Pooley in press) of NWHI lobster fishing vessel economic performance summarized information on the economic performance of 12 lobster vessels that fished in 1985 or 1986, and provided fleet-wide estimates for lobster fishing industry income in 1986. Because of confidentiality problems (small number of vessels in each class), it is not possible to reproduce the detailed results using information from 1987 operations. Furthermore, new fishing vessel cost information was not collected in 1987. Nonetheless, we did make a projection of fleet-wide income for 1987 (Table 9). Some "prototypical" lobster fishing vessel economic information was calculated as if the cost structure remained essentially the same as in 1985-86. Some unit prices (such as the cost of bait and fuel) were adjusted to 1987 levels. Costs and earnings in 1987 are estimated for a midsize vessel (a composite vessel for Classes II-III) (Tables 10 and 11). The methodology is described in Clarke and Pooley (in press). Finally, physical use rates for the prototypical midsize vessel are shown in Table 12.

¹Polovina, J. J. Density dependency in spiny lobster, Panulirus marginatus, in the Northwestern Hawaiian Islands. Manuscr. in prep. Southwest Fisheries Center Honolulu Laboratory, National Marine Fisheries Service, NOAA, 2570 Dole Street, Honolulu, HI 96822-2396.

Table 9.--Income estimations for the lobster fleet operating in the Northwestern Hawaiian Islands, 1986 and 1987.^a

Fleet income	Income (in millions US\$)	
	1986	1987
Gross revenue	6.2	4.1
Net revenue	-0.2	0.3
Labor income	1.8	1.2
Total income	1.6	1.5

^aFigures in this table are estimated from annualized estimates of earnings per vessel.

Gross revenue for the NWHI lobster fleet was approximately \$4.1 million in 1987. Net revenue (i.e., gross revenue minus all costs) was estimated at \$340,000, whereas labor income (crew and captain's shares) was estimated at \$1.2 million. These figures compare with 1986 gross revenue of \$6.2 million, -\$198,000 in net revenue, and \$1.8 million in labor income. Thus, although total gross revenue was down by one-third in 1987, total income (labor plus net revenue) only declined by 6%. This represents a higher level of operating efficiency in 1987 because of a more appropriate fleet configuration.

Most of the Class I vessels left the fishery at the end of 1986, and only two Class I vessels participated in 1987. As indicated in Clarke and Pooley (in press), the Class I vessels were in marginal economic condition at the end of 1986 because catch rates in the fishery were insufficient to cover their large fixed costs. The Class I vessels that fished in 1987 experienced a number of operational problems (e.g., breakdowns), and their economic performance was probably poor.

If the Class I vessels had operated as their class had in 1986, but their prices and catch rates were adjusted by the ratio of 1987 to 1986 fleet-wide average rates, then their 1987 per vessel gross revenue would have increased by 15% (the same for all classes, by definition), their net revenue (losses) improved by 48%, and their total income per vessel (net revenue and labor income) by 29%. We reiterate that these are prototypical estimates.

Class II vessels were identified by Clarke and Pooley (in press) as being the most profitable, with their profits derived from high operating levels and efficient cost structures. It would appear that conditions for these vessels would have been optimal in 1987 because their competition from the Class I vessels was markedly reduced.

Table 10.--Typical income statement and operating characteristics for a mid-sized lobster vessel operating in the Northwestern Hawaiian Islands, 1987 (composite of Class II and Class III vessels).

Income statement	US\$
Revenue	495,563
Fixed costs	119,863
Capital cost and recovery	39,701
Repairs	18,530
Vessel insurance	28,570
Administrative	10,524
Other	22,538
Operating costs	251,246
Fuel and oil	28,371
Bait	26,326
Handling	2,394
Provisions	12,403
Medical	353
Supplies	3,653
Gear	15,064
Other	6,130
Crew share	143,957
Captain's share	12,596
Total cost	371,109
Net revenue	124,454
Operating Characteristics	
Investment (\$)	390,375
Trips (No.)	4.17
Catch per trip (lb)	285
Trip days (No.)	178
Fishing days (No.)	137
Crew share (%)	36
Product price (\$/lb)	12.69
Depreciation factor	0.07
Capital factor	0.08

Table 11.--Cost per pound and as percentage of total cost, for a typical midsize lobster vessel operating in the Northwestern Hawaiian Islands, 1987 (composite of Class II and Class III vessels).

Income statement	Cost (US\$/lb)	Percent
Revenue	12.69	133.54
Fixed costs	3.07	32.30
Capital cost and recovery	1.02	10.70
Repairs	0.47	4.99
Vessel insurance	0.73	7.70
Administrative	0.27	2.84
Other	0.58	6.07
Operating costs	6.43	67.70
Fuel and oil	0.73	7.64
Ice	0.00	0.00
Bait	0.67	7.09
Handling	0.06	0.65
Provisions	0.32	3.34
Medical	0.01	0.10
Supplies	0.09	0.98
Gear	0.39	4.06
Other	0.16	1.65
Crew share	3.69	38.79
Captain's share	0.32	3.39
Total cost	9.50	100.00
Net revenue	3.19	33.54

If the Class II vessels in 1987 had operated as in 1986, but their prices and catch rates were adjusted by the ratio of 1987 to 1986 fleet-wide average rates, then Class II net revenue per vessel would have improved by 26%, and their total income (net revenue and labor income) would have improved by 18% in 1987.

Class III vessels are physically similar to Class II vessels but fish at a lower level of intensity. It appears that this was again true for 1987, although economic performance probably improved on average.

If the Class III vessels had operated as in 1986, but their prices and catch rates were adjusted by the ratio of 1987 to 1986 fleet-wide average rates, then their net revenue (losses) per vessel would have improved by 3%,

Table 12.--Physical use rates for a typical mid-sized lobster vessel operating in the Northwestern Hawaiian Islands, 1986-87 (composite of Class II and Class III vessels).

Cost item	Unit price (US\$)	Quantity	Units
Fuel and oil	0.73	279	Gallons per sea day
Bait	0.30	640	Pounds per fishing day
Handling	0.06	--	Pound
Provisions	12.17	--	Crew per sea day
Medical	14.83	--	Crew member per trip
Supplies	20.47	--	Sea day
Gear	25.22	595	No. of traps per trip
Other	34.36	--	Sea day
Crew share	183.66	784	Crew day per trip
Captain's share	70.60	--	Sea day

Operating Characteristics

Trips (No.)	4
Catch per day (lb)	285
Trip days (No.)	178.41
Fishing days (No.)	137.17

but their total income per vessel (net revenue and labor income) would have improved by 71% in 1987.

These results suggest that the NWHI lobster fishing industry as a whole was again at the open access level of economic performance; i.e., the fleet as a whole generated minimal profits (\$300,000 on a current investment of some \$5 million), but some individual vessels were able to do quite well. Industry leaders have argued that the fishery will "regulate itself" based on the economics of fishing operations. The "front end" costs of lobster fishing trips (bait, fuel, supplies, gear, and transit costs to the fishing grounds), the learning curve aspect of the fishery, and the experience of a number of entrants to the fishery suggest that effective fishing pressure will not be applied and sustained on a casual basis. Those who stay in the fishery, whether on a regular or pulse fishing basis, are extremely sensitive to conditions on the fishing grounds. From a biological point of view, with the current regulations, which attempt to protect the reproductive capacity of the lobster stocks, it appears that self-regulation of the fishery may indeed occur. From an economic point of view, where rates of return on investment for the fleet as a whole are low, and where the flow of income may be disrupted by variations in catch rates between years, the fishery alone is not operating at an optimal level. It is possible but not a certainty that this level of operation is optimal on a mixed fishery basis (where vessels can enter and exit the fishery easily). Whether the fishery should be

managed for biological or economic optimums is a political question, although biology and economics can contribute information to that decision.

Economic research will continue in 1988 with a study by the Western Pacific Regional Fishery Management Council (Council) on the effects of other management alternatives for the fishery (e.g., closed seasons or areas, gear restrictions). All of these options are being explored so that, if in the future additional management restrictions prove necessary, the data base will be in place to address the economic effects of different management alternatives.

COUNCIL ACTIVITIES

Planning Team and Advisory Panel Action

The Crustacean Plan Monitoring Team (PMT) met three times during the 13-mo interval from February 1987 through February 1988. Two meetings of the Advisory Panel (AP) were held within that same period.

In the meetings held early in 1987, the discussions among both groups centered on actions under consideration for Amendment 5--most notable, the minimum legal size for slipper lobsters and the requirement for escape panels in lobster traps. Both groups recommended a 5.6-cm tail width as the minimum legal size for slipper lobster, based on both biological and economic rationale. Research had confirmed that 1) slipper lobster with a 5.6-cm tail width weighed 3.6 oz on average and 2) the most valuable and marketable sizes of slipper lobster tails are those larger than 4 oz.

The NMFS research demonstrated the effectiveness of escape panels at reducing catches of sublegal lobsters, both slipper and spiny. The PMT and AP judged that circular vents 67 mm in diameter yielded the most desirable results, and both groups concurred that, after 1 January 1988, all traps must have escape panels. That timing would not encumber fishermen with gear transitions until the year's end, a time when vessels normally are inactive because of holidays and rough winter seas.

The Scientific and Statistical Committee discussed and endorsed the recommendations made by the PMT and the AP, and both suggestions, along with a variety of reporting requirements, were incorporated into Amendment 5. In March 1987, several active fishermen petitioned the Council to consider limiting entry to the NWHI lobster fishery. Consequently, that topic was discussed thoroughly throughout the year. The PMT framed its deliberations on 1) the status of the stocks report (Polovina et al. 1988) and 2) on the results, as they became available, of four phases of economic research on the fishery. The PMT viewed this research as the appropriate avenue to address concerns about limited entry and did not recommend going forward with a limited entry program.

The early February 1988, the PMT met informally to discuss the 1987 report on the status of the stocks (Polovina et al. 1988). The report listed a revised MSY figure of 716,000 lobsters, spiny and slipper lobsters

combined, for the entire NWHI. That figure was less than half of the previous year's estimate of 1.5 million lobsters. Still, the PMT did not recommend limited entry, particularly because no difference in the overall abundance of recruits was evident and the stocks do not appear to be in danger biologically. Rather, the PMT recommended frameworking the present FMP. The team elaborated that the framework FMP should include contingency measures to implement if the biological health of the stocks becomes threatened (i.e., recruitment for an entire year class is catastrophically low due to some natural phenomenon), and that the FMP identify conditions or indicators that call for effort limitation measures.

Council Action

Amendment 4 was implemented on 25 March 1987. That amendment was intended to preserve the refuge areas that were established within 20 nmi around Laysan Island and in waters shallower than 10 fathoms throughout the NWHI. A regulatory loophole existed that arguably permitted the harvest of slipper lobster within designated refuge areas.

The Council also approved several actions packaged in Amendment 5. The proposed actions included establishing a minimum legal size for slipper lobster, a requirement that lobster traps have escape panels, mandatory reporting of slipper lobster catches, a requirement to report bycatches of octopus and other commercially valuable species, modification or elimination of several sales, processing, and transshipment forms, and changing the name of the Spiny Lobster FMP to the Crustacean FMP. Amendment 5 was implemented on 14 January 1988.

The Council sponsored a public meeting in early February to inform fishermen of the results of the economic research conducted over the past 18 mo. Particular emphasis was directed at the potential effects of various effort limitation schemes on the profitability of individual operators. Fishermen were keenly interested in the conclusions because much of the research, either directly or indirectly, addressed limited entry.

For much of the past year, the Council considered whether to proceed with plans for limited entry in the NWHI lobster fishery. After discussing results on the status of the fishery for 1987 and reviewing the economic research, the Council voted not to proceed with a limited entry plan at this time. Instead, it concurred with the recommendations of the PMT and the Scientific and Statistical Committee to framework the Crustacean FMP.

ENDANGERED AND THREATENED SPECIES

Interactions

The Daily Lobster Catch Report per Statistical Area form provides space to report monk seal, Monachus schauinslandi, and sea turtle sightings or interactions in the NWHI lobster fishery (Table 13). In 1987, fishermen hauled gear on a total of 1,217 d and reported sighting or interactions with

Table 13.--Reported sightings with endangered or threatened species and the lobster fleet in the Northwestern Hawaiian Islands, 1987. Statistical areas are defined in the Daily Catch Report per Statistical Area form.

Area	No. of sightings by No. of individuals	
	One individual	Two individuals

Monk seals observed in statistical area

Nihoa Island	2	
Pearl and Hermes Reef	1	
Maro Reef	4	
Necker Island	12	3
St. Rogatien Bank	11	
Brooks Banks	2	

Monk seals observed in vicinity of fishing gear

Maro Reef	1
Gardner Pinnacles	1
St. Rogatien Bank	2

Turtles observed in statistical area

Pearl and Hermes Reef	3
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Turtles observed in vicinity of fishing gear

Necker Island	1
St. Rogatien Bank	1

monk seals on only 44 different occasions. Monk seals were observed in the general statistical fishing area on 35 different occasions and in the vicinity of the fishing gear on 4 occasions. Necker Island was the area of the most sightings of monk seals in 1987, followed by St. Rogatien and Maro Reef. There were no reports of seals feeding on discarded lobster, or other significant fishery mammal interactions in 1987. Turtle sightings were reported on only five different occasions in 1987, three at Pearl and Hermes Reef, one at Necker Island, and one at St. Rogatien Bank. Fishermen may sight greater numbers of monk seals and turtles but may not take time to report them during what are usually quite hectic daily fishing operations. Therefore, these numbers of sightings and interactions are not considered to be an accurate quantitative indicator of abundance.

SUMMARY

1. All of the fishing regulated by the Crustacean FMP took place in the NWHI, permit area 1.
2. In 1987, 240 t of spiny lobsters (wet weight) were landed, valued at \$1.6 million, while 200 t of slipper lobsters were landed, valued at \$1.6 million. Total ex-vessel revenue in 1987 was \$4.1 million, down 33% from 1986.
3. Logbooks indicate that 349,556 legal spiny lobsters and 476,568 total slippers were caught in 1987. Both are down significantly from record 1986 catches.
4. The three most important fishing grounds, in descending order, for spiny lobsters and also slipper lobsters were Maro Reef, Necker Island, and Gardner Pinnacles.
5. A total of 11 federally permitted vessels took 38 trips and fished 804,711 trap-hauls in the NWHI. Effort, in trap-hauls, was greatest at Maro Reef, Necker Island, and then Gardner Pinnacles.
6. The catch rate, in numbers per trap-haul, for legal spiny lobsters continued to decline, from 0.66 in 1986 to 0.49 in 1987. The total spiny lobster CPUE declined from 1.01 in 1986 to 0.91 in 1987. The total slipper lobster CPUE declined from 0.91 in 1986 to 0.59 in 1987. The combined legal spiny and total slipper lobster CPUE dropped 31% from 1986 levels.
7. The ex-vessel price of all lobster products rose substantially in 1987, with frozen spiny lobster tails averaging \$13.06/lb and slipper lobster tails averaging \$10.64/lb.
8. Biological assessment studies indicate that despite continued drops in CPUE, lobster stock recruitment appears healthy, although there may be recruitment differences at certain banks in the NWHI.
9. Economic analysis indicates that the fishery is performing as expected for an open access fishery in which profits, on average, are approximately equal to losses.

ADMINISTRATIVE AND ENFORCEMENT ACTIVITIES

The year 1987 marked the fifth year of enforcement of regulations since the Spiny Lobster FMP was implemented in March 1983. With the approval of Amendment 5 to the FMP in 1987, a number of important changes to the lobster FMP were implemented. These changes, described earlier in the section on Council actions, reflect the evolution of the lobster fishery from a single species fishery (spiny lobster) to a two species fishery (spiny and slipper lobsters). The renamed FMP continues to require

permits of all vessels that fish for lobsters in the FCZ of the western Pacific.

No significant enforcement problems surfaced during the year. Seeking compliance of lobster regulations through a continuing program of education, information, and enforcement has worked remarkably well. The success of this approach is evident in the drastic reduction in serious resource-threatening violations.

Permits

A total of 41 vessels were issued permits for the lobster fishery in calendar year 1987. This is less than the record 54 permits issued in 1986 and the 45 permits issued in 1985. The total trap carrying capacity for permitted vessels in 1987 was 31,200. Of the 41 vessels permitted, only 3 requested permits to fish in permit area 2, the FCZ around the main Hawaiian Islands. All the others were permitted for the NWHI, permit area 1. No permits were issued for permit area 3, the FCZ around American Samoa and Guam.

In 1987, only 11 of the 41 vessels issued permits actually participated in the fishery. This is markedly lower than the 16 vessels that participated in the fishery in 1986. Of the 11 vessels actively engaged in the fishery in 1987, 3 were entrants to the fishery and the remaining 9 vessels were carry-overs from the 1986 active fleet. Most of the vessels exiting the lobster fleet in 1987 relocated to other fisheries in the Pacific Northwest and Alaska region. The 11 active vessels in 1987 carried a total of 9,150 traps. This represents a significant decrease from the 13,580 traps carried by the active fleet in 1986 (Table 14).

Table 14.--Permit and vessel activity in the spiny lobster fishery in the Northwestern Hawaiian Islands, 1983-87.

Year	Permits issued	Active vessels	Trap carrying capacity of active vessels	Average trap carrying capacity of active vessels
1983	14	4	1,200	300
1984	19	11	5,240	476
1985	45	16	12,250	703
1986	54	16	13,580	849
1987	41	11	9,150	832

Enforcement Activities and Violations

In 1987, the NMFS enforcement agents inspected 14 lobster vessels that landed their catch in Honolulu. Agents are not aware of any landings of lobsters other than in Honolulu. Only two violations that required formal documentation were observed. Both of these were for failure to provide 24-h notice prior to landing lobster. One verbal warning was given for not maintaining the required 6.5-in diameter maximum entrance cone. The older style pots required leaving single vertical bars in the entrance cone to meet size requirements. After these traps age with use, the bars break, thereby enlarging the openings.

The 3 violations detected in 1987, compared to 9 violations in 1986 and 22 in 1985, certainly illustrate that the Hawaii commercial lobster fishermen understand the lobster regulations and are complying with the laws. A summary of 1986 enforcement actions are contained in Table 15.

Table 15.--Violations of spiny lobster regulations 1985
(EAR = Enforcement Action Report).

No.	Violation	Action
1.	Failure to report 24 h in advance	EAR issued
2.	Failure to report 24 h in advance	EAR issued
3.	Fishing with lobster traps with openings exceeding 6.5 in	Verbal warning

Enforcement Problems

The communication problems that plagued both the U.S. Coast Guard and the NMFS since the FMP's inception appear to be finally under control. This is due largely to a concentrated effort by Coast Guard communications staff and personnel to identify the problem and implement actions to correct the situation. Transfers and promotions of Honolulu agents in 1987 reduced enforcement capabilities considerably, but the Honolulu office is back to a full complement of three agents and a secretary which will allow goals of education, information, and enforcement to be met.

RECOMMENDATIONS

1. The Southwest Region (SWR) recommends that the Council proceed with a restructuring of the Crustacean FMP as a framework plan to allow more timely responses to any changes in the fishery.
2. The SWR recommends that the Council continue monitoring the lobster fishery closely to evaluate the effectiveness of new management measures and to verify the accuracy of recent estimates of MSY.

3. The SWR recommends that the Council continue to hold public information meetings with the lobster industry, as appropriate, to discuss ongoing activities, problems in the fishery, and possible management needs.
4. The SWR recommends that studies or reports related to the lobster fishery continue to be distributed to industry participants on a timely and regular basis.

Southwest Fisheries Center Recommendations

The Southwest Fisheries Center has no recommendations this year. The institution of escape gaps is a major conservation measure that we will monitor closely.

REFERENCES

- Clarke, R. P., P. A. Milone, and H. E. Witham.
1987. Annual report of the 1986 western Pacific lobster fishery.
Southwest Fish Cent. Honolulu Laboratory, Natl. Mar. Fish. Serv.,
NOAA, Honolulu, HI 96822-2396. Southwest Fish. Cent. Admin. Rep.
H-87-6, 47 p.
- Clarke, R. P., and S. G. Pooley.
In press. An economic analysis of Northwestern Hawaiian Islands lobster
fishing vessel performance. U.S. Dep. Commer., NOAA Tech. Memo.
NMFS, NOAA-TM-NMFS-SWFC.
- Clarke, R. P., and A. C. Todoki.
In press. Comparison of differing methods of calculating catch per
unit effort in the Northwestern Hawaiian Islands lobster fishery.
Southwest Fish. Cent. Honolulu Laboratory, Natl. Mar. Fish. Serv.,
NOAA, Honolulu, HI 96822-2396. Southwest Fish. Cent. Admin. Rep.
- Gates, P. D., and K. C. Samples.
1987. Market situation and outlook for the Northwestern Hawaiian
Islands spiny and slipper lobsters. Southwest Fish. Cent. Honolulu
Laboratory, Natl. Mar. Fish. Serv., NOAA, Honolulu, HI 96822-2396.
Southwest Fish. Cent. Admin. Rep. H-87-4C, 33 p.
- Polovina, J. J., A. R. Everson, and T. K. Kazama.
In press. Evaluation of circular and rectangular escape vents in a
multispecies lobster fishery in Hawaii. Proceedings of the Fortieth
Annual Gulf and Caribbean Fisheries Institute.
- Polovina, J. J., R. B. Moffitt, and R. P. Clarke.
1988. Status of stocks of lobsters in the Northwestern Hawaiian
Islands, 1987. Southwest Fish. Cent. Honolulu Laboratory, Natl. Mar.
Fish. Serv., NOAA, Honolulu, HI 96822-2396. Southwest Fish. Cent.
Admin. Rep. H-88-3, 8 p.
- Samples, K. C., and J. T. Sproul.
1987. Potential gains in fleet profitability from limiting entry into
the Northwestern Hawaiian Island commercial lobster trap fishery.
Southwest Fish. Cent. Honolulu Laboratory, Natl. Mar. Fish. Serv.,
NOAA, Honolulu, HI 96822-2396. Southwest Fish. Cent. Admin. Rep.
H-87-17C, 30 p.
- Schnute, J.
1977. Improved estimates from the Schaefer production model:
Theoretical considerations. J. Fish. Res. Board Can. 34:583-603.

